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CONSERVATION AND SOLAR ENERGY RESEARCH AND DEVELOPMENT

HEARING

BEFORE THE

SUBCOMMITTEE ON
ENERGY RESEARCH AND DEVELOPMENT

OF THE

COMMITTEE ON
ENERGY AND NATURAL RESOURCES
UNITED STATES SENATE

ONE HUNDREDTH CONGRESS

FIRST SESSION

ON THE

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IN THE FEDERAL GOVERNMENT

ATLANTA, GA, JULY 13, 1987

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CONSERVATION AND SOLAR ENERGY RESEARCH AND DEVELOPMENT

MONDAY, JULY 13, 1987

U.S. Senate,
Subcommittee on Energy Research and Development,
Committee on Energy and Natural Resources,
Atlanta, GA.

The subcommittee met, pursuant to notice, at 9:30 a.m., at the Georgia Power Building, Hon. Wyche Fowler, Jr., presiding.

OPENING STATEMENT OF HON. WYCHE FOWLER, JR., A U.S. SENATOR FROM THE STATE OF GEORGIA

Senator Fowler. Ladies and gentlemen, I want to welcome you to the first field hearing of the 100th Congress of the United States on renewable energy policy. Of course it gives me great personal pleasure to come to my own state to learn more about the status of renewable energy. We have a very fine and diverse witness list and we look forward to hearing from them momentarily.

Today we are going to address an issue as important, I believe, as any facing our country. I think it is as important as our budget deficits, as important as our defense policy, because it is very much a part of our international competitiveness and our national security, though it has received decidedly less attention. That issue is our national energy policy, or rather the lack of one.

We have devoted precious little effort and depth of thought to the questions of—what will power our homes and factories in the next century—what will our transportation systems run on? Without the answers to these questions, it is very difficult to imagine real progress in our nation's future.

None of the shocks and stutters of the last few years have brought us to our senses or even brought our energies fully to bear. We had fair warning when the Arab-Israeli War of 1973 caused oil to triple in price from $11.00 a barrel. We were warned at the time of the Iranian Revolution of 1979. By 1982, the price of a barrel of oil, as we all remember, was an unheard of $32.00 or so per barrel. One of the real questions that we are addressing or trying to address, should address in the Nation's capital, is whether or not we are going to continue to sit on our hands and wait for the next crisis to develop.

So what have we done? Well unfortunately, at least for some of us, we believe we have gone the opposite way. We have cut research and development into alternative energy sources by 80 percent since 1980. United States firms, which once held the technological edge, have lost their lead in wind power to the Dutch, in photovoltaics to the Japanese. I could go on and on. We have allowed short-term market forces to preempt a long-term, sound strategy.

Later this month I will introduce legislation to encourage development of renewable energy resources that can reduce our dependence on foreign oil. We do have unlimited potential, as we will hear this morning, in solar, wind, photovoltaics, hydropower, geothermal, biomass, many others. We have huge grain surpluses stored all over this country which could be made into energy. Anything that ferments you can make energy out of. And yet, we are not doing what can be done, and what I believe, must be done.

Today's hearing will help make the case for a national energy policy. I want to thank all of our witnesses in advance for the excellent testimony that they have submitted. I want to especially thank our host, Georgia Power Company, for allowing us to hold our Congressional hearing in this state-of-the-art facility, and I want to thank especially all of my friends at the Georgia Institute of Technology for their invaluable assistance in putting this together and making it happen.

I do hope you will take the time to look at the displays on your way out. You will be very impressed with what is going on, not only in the overall energy field but with what is going on in our state.

Let me introduce Frances Zwenig, who is Chief Counsel of my staff in Washington and does my work on the Energy and Natural Resources Committee. With us are Cheryl Moss of the professional staff of the Energy and Natural Resources Committee; Richard Grundy, who is Senior Professional Staff on the Committee and Teri Curtin, Staff Assistant. So we have the full array of Washingtonians coming down to listen to you and learn from you.

We have one surprise guest to lead off. We are very pleased to have a member of the Public Service Commission, my friend, Mr. Billy Lovett, Dublin, Georgia, who joins us in his citizen capacity and his elected capacity.

Commissioner Lovett, we will be glad to hear from you to help us kick this off.

STATEMENT OF BILLY LOVETT, COMMISSIONER, GEORGIA PUBLIC SERVICE COMMISSION

Mr. Lovett. Thank you very much, Senator, and your interest and your work in this area through the years is much appreciated. I had originally thought I was not going to be able to be here because of the Commission hearings on the Plant Vogtle issue, and I must apologize, I will have to get back shortly to resume my study and researching of that case, but the original hearing has been postponed to a later date, so I am able to be here with you today and I appreciate the invitation.

I would like to just comment briefly—and I have my comments produced in letter form to you and also some material that I have given to your staff to be copied into the record*—but basically I would like for us to keep in mind just a couple of things when we are talking about Federal energy research and development.

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*The material appears in the Appendix.

The eight years that I have looked at this issue, and I would not be presumptuous to tell you I have the solution, but I have learned I believe one basic thing. There is a lot of research that is being done in a lot of different sectors; Federal, state and the private sector. In talking to people over at Georgia Tech or the University of Georgia; whether it is Fred Davison who is in the biotech area or Tom Stelson or the Electric Power Research Institute or the Gas Research Institute, there is a lot being done but we all agree that there is much more that needs to be done and we do need a clear direction, we do need defined for us the things that we need to be spending more time and more dollars on.

But it is not, of course, all up to the Federal Government. There is much that can be done and should be done from a state level. I think that North Carolina and New York State are two examples that people should look very closely at, as far as those states aggressively pursuing a renewable energy technology. I have outlined for you in my letter, some of those states in addition to New York and North Carolina, but I think they should serve as models. New York does have an R&D Energy Authority, North Carolina does as well. They do commit state dollars, they do a lot of good on a lot of different technologies. They of course cannot, and probably should not, be doing research at all.

But one of the things, the common thread that I hear in talking to so many people is that—whether it is TVA who I think also has excellent research capabilities and I have been impressed with their people—I think there are a lot of people and a lot of institutions from all of the sectors that are duplicating some of the same basic research. There is a lot of competition, even in our state between Georgia Tech and the University of Georgia on research dollars, wherever they are coming from. And I think when that happens in a political sense you wind up giving little pieces of R&D dollars out to all of these institutions and you do not really concentrate the dollars where they need to go in sufficient quantity to really come up with those breakthroughs that you need to come up with.

So I hear from a lot of these institutions how much duplication and how much competitiveness there is for these funds, and it is good for competition to occur, but I think we really need to focus in on a couple of specific areas.

I would like to again enter into the record, three papers entitled "Comprehensive Energy Planning Report for the State of Georgia", "The Role of Energy in a Changing Environment for Agri-Business". I think we do have a lot of potential in this state and a lot of other states in the United States. And an additional paper which covers energy planning in the co-generation area.

Just four or five last points and these are from some papers that I have just been studying recently.

1. The Federal Government must redefine its research and development role in renewables and be careful not to repeat some of the mistakes of the past. A publication which I particularly favor is "A Decade of Energy R&D, Implications for the Future" by Dr.

Eugene Franklin, Senior Analyst, Program in Science, Transportation Innovation, Office of Technology Assessment, U.S. Congress.

2. Aggressive state energy research and development, strategic planning. "Managing the Transition State for Energy Strategic Planning" by T.A. Kohler, Supervisor of Energy Management Services, Eastman Kodak Company.

3. Much is being done in the private sector but some additional incentives need to be provided. I would refer you to Electric Power Research Institute Journal for June, 1987 and the Gas Research Institute Annual Report, 1986.

Lastly, in addressing new electric power technology, I would refer you to the summary entitled "Problems and Prospects for the Nineties" published by the Office of Technology Assessment. I think that that office, who I know you are very familiar with, has done an excellent job in summing up in a very brief fashion some of the problems and suggestions for solutions, what we need to do. I would concur almost 100 percent with their suggestions.

With that, Senator, I will conclude.

Senator FOWLER. Billy, thank you so very much and any and all of your research papers or documents will be made a part of the record. I do know how busy you are at this particular time, so I wish you God speed and thank you so much for taking time to be with us this morning.

Mr. LOVETT. Thank you.

Senator FOWLER. Ladies and gentlemen, let me read the witness list this morning and we will call them up in that order. If all the witnesses will try to stay within the ten-minute guidelines, summarize their testimony, and leave us plenty of time for questions, I would like to have all six of you have a round-table about what you have heard and help me and us summarize the conclusions and the consensus that might emerge.

First will be Mr. Ernest Ellingson, Vice President of Georgia Power Company. Following him will be Mr. Daniel O'Neil from Georgia Tech. Following him will be Mr. Dwight Jones, principal of Jones, Nall and Davis in Atlanta. Following him will be Mr. Jeff Tiller of Southface Energy Institute in Atlanta. Then Mr. John Mixon, the Director of the Georgia Forestry Commission. And last but not least will be Paul Burks, the Director of the Office of Energy Resources of the Governor.

Mr. Ellingson, welcome. We are delighted again at your company's hospitality in making this facility available to save the taxpayers a little money. Your complete statement will be made part of the record. Proceed any way you would like.

STATEMENT OF ERNEST G. ELLINGSON, VICE PRESIDENT, MARKETING SERVICES, GEORGIA POWER CO.

Mr. ELLINGSON. We are glad to have you here and appreciate the opportunity to speak today.

To begin with, I would like to read a statement from Ed Addison, President of the Southern Company, the parent of Georgia Power.

> The Southern Company is more than a conventional energy company. We are dedicated to the development of all forms of energy that can provide economic, reliable and environmentally safe service to our customers.
>
> At our research centers, we are evaluating solar energy applications to insure that we go into the 21st Century with viable energy supply options. Shared energy

programs with the Electric Power Research Institute, the Federal Government, industry and other utilities are increasing the return on our research dollars and helping us to better serve our stockholders.

The electric utility industry and Georgia Power have invested heavily in the past and continue to invest heavily in research and development of photovoltaic devices. There is a list in my testimony of ten projects, two of which are very large; the power tower of Southern California Edison in the Mojave Desert and STEP, Solar Total Energy Project, here at Georgia Power Company, are the two largest demonstration projects existing in the world.

The two of them combined, the DOE has spent approximately $200 million on just those two projects over the last eight to ten years. Currently the DOE has $123.5 million to spend on solar research and has requested for fiscal year 1988 only $71.2 million, and I would like to speak to that a little later.

Since fossil fuel prices have fallen and the Federal Government is in a position of having to control its expenditures more than it has in the past, Congress must place new attention on which solar projects to fund as well as how much to spend.

Basically we can break solar energy projects into two categories; one is basic research and development and the other is demonstration projects. Georgia Power Company believes that the Federal Government should concentrate its spending on basic research and development. And there are two reasons for our believing that.

First, a number of projects that are underway in the United States offer great promise for reducing the cost of solar energy. One of the things that has to happen, however, is additional breakthroughs in the efficiencies of photovoltaic cells. We believe that there is some risk involved, some projects require three and as large as ten times improvement in either throughput of the manufacturing process or the efficiency of the device itself. Now given those risks and the fact that the Federal Government likely will not allow firms which undertake the risk to reap large rewards in the event of an oil crisis or some quick run up in fossil fuel prices, we believe the Federal Government should finance most of the research and development in those areas.

Second, demonstration projects cannot yield anything except knowledge about scaling up existing technologies. Given the low fuel prices we have in the United States right now, we have an opportunity to take some time to develop the promising techniques and then scale them up because that is where the rewards really will occur. Scaling up existing technologies, we may learn something about it but by the time we use it in the mid-nineties to the late nineties, they will already be superseded by technologies that would have superior performance and we would have wound up spending resources to demonstrate things that we will really not use very much when solar becomes a feasible alternative.

We believe that the DOE should have available at least $123.5 million. That is the current funding. It is not what they are asking for but we think that would be an appropriate level for research and development funds for the DOE——

Senator FOWLER. Continuation of current levels?

Mr. ELLINGSON. At least that much, yes, sir. There are specific areas that those research funds should be applied to. First, we need a better understanding of the physics of materials used to make photovoltaic devices. The problem with many photovoltaic devices is that they have low efficiencies and in order to generate enough electricity, you need equipment to support the devices themselves and it is known in the engineering parlance as a balance of plant. That is the land, structures—and the less efficient the cell, the more of these supporting structures are necessary and that is what raises the cost of the solar device and makes it uneconomic. So we need to find out particularly the physics of amorphous silicon because it is the lowest cost to produce solar photovoltaic device, but its efficiencies are low, they degrade very fast. We need to understand what could make their lifetimes longer so that once they are built, they can stay operable for a long period of time and the plant can be depreciated over a significant amount of time rather than having to recover all of its costs in a few years. There is some research going on at Georgia Tech, Professor Ajeet Rohatgi is doing research in the physics of solar devices. He has the equipment to test and he has excellent graduate students and other staff members that he is working with, and his funding and funding like his should be continued.

We need to do more basic research in the cell development process. There are some single crystal cells being developed at Westinghouse. The technique has been funded in part by the DOE. It is known as the dendritic web process where single crystals are pooled in a web. They have pulled as long as 17—a cell 17 meters long, which is—and they are trying to reach an average of about five before the cell breaks and they have to replenish it. They are not at that average level right now and that funding needs to continue for that project because it does show great promise.

Solarex is another manufacturer. They are using an amorphous silicon. They have been funded—at least the research into the efficiency of the cell has been funded by the DOE. That funding should also continue because they are very near the kind of breakthroughs that are necessary to make it efficient.

The DOE should continue to fund the development of concentrators. As you know, the STEP project uses concentrators to focus the sun's energy on one place and take off very high temperatures. We also have at Shenandoah a Stirling engine that is powered by the sun. And the Stirling engine techniques also show great promise but the concentrators are such heavy structures—the one we have in the Stirling engine uses glass as a reflector because glass does not deteriorate and is strong enough to withstand hail, but it is very heavy. So you need large supporting structures and you need large machines to stow them in case of high winds. What we need to do is to develop lightweight concentrators, which means we have to find some thin film technologies as well as some simple designs to make concentrators more effective. Sandia National Labs is working on those areas and their funding should also be continued.

We need to concentrate some on solar thermal energy, and basically there are two techniques; the free piston Stirling engines and engines using the Brayton cycle, either one of which could become very efficient producers of electricity. We have demonstrated 25 percent efficiency with the Stirling engine at Shenandoah, which means 25 percent of the energy that is striking the engine is being converted into electricity, which is about twice as high as the average conversion rate for photovoltaics right now. So it does have some promise. They are complicated techniques, a lot of work needs to be done on control systems as well as the development of the kind of coolants to use in the engines.

In addition, in the southeast, we could likely use heat engines better than the southwest can because the solar peak occurs in the early afternoon, between two and three o'clock in the afternoon, and the electric peak on our system occurs about two hours later. So just as we need the solar energy, it is falling off in the southeast. And what we can do with a Stirling engine is heat it with another form such as fossil fuel and run those for the two or three hours when we need to get through that peak. So we can combine solar and fossil fuels inside heat engines. That is the reason that research should continue there.

We also have a unique problem in the southeast with moisture and humidity and there are techniques around to use desiccants for cooling. Basically they dry the air rather than using air conditioners and there is a unique solar application to dry the desiccants with solar energy. So you literally get solar air conditioning and it removes the latent heat from the air. The Florida Solar Research Center is doing studies there and that should continue.

The last area the Government should fund is collaborative efforts between government agencies working on energy related studies, universities and private industry. NASA is doing a lot of work on space applications of solar energy. They are probably the premier experts on space application. A lot of those things could be applied on the earth and we need to make sure that agencies that can contribute to one another have forums to get together. We also think that research going on in superconductors could yield a specific advantage to solar energy because we believe that first application will be in storage techniques and that is one thing that makes solar go, the ability to have efficient storage.

The Solar Research Institute has a——

Senator **Fowler**. Has the Power Company been able—before I forget it, has the Power Company been able to take advantage of any of the technological spinoffs from the space program? Is there coordination at least on an informational basis so that it gets to you?

Mr. **Ellingson**. We pay close attention to papers written by NASA. We currently have a study at Bob's Candies, which produces all the candy canes in the world—in fact, virtually all of them, really. We have a heat pipe application there to reduce the need for resistance heat to reheat air in the air conditioning process. What happens in a large commercial application is you cool air down too fast in a room and you do not remove the humidity and that is—it is necessary to remove the humidity, so what the heat pipe does is transfer heat from the return air and reheats the cold air coming back in, so that it comes in dryer.

Senator **Fowler**. Was that learned from the space program?

Mr. **Ellingson**. NASA has done most of the development work on heat pipes and they show tremendous applications, not just in——

Senator **Fowler**. Not just in making candy canes.

Mr. ELLINGSON. Not just in making candy canes, that is right. They have tremendous application in commercial office buildings and we are examining those now to see just how they work and what is effective and what is not.

In closing, we believe the United States has a window of opportunity, created by low fuel prices, to develop high efficiency solar technology. We believe that these devices will have high value when oil prices rise to the $25 to $30 per barrel in 1986 dollars. And we cannot wait for prices to get that high before we act. We must do things now to prepare for those increases. However, we believe the United States would waste its research and development resources by spending them on demonstrating already known techniques or techniques that became available in the last few years.

Thank you.

[The prepared statement of Mr. Ellingson follows:]

PREPARED STATEMENT OF
ERNEST G. ELLINGSON
VICE PRESIDENT, MARKETING SERVICES
GEORGIA POWER COMPANY
BEFORE THE UNITED STATES SENATE
SUB-COMMITTEE ON ENERGY RESEARCH & DEVELOPMENT

The electric utility industry and Georgia Power invested and continue to invest heavily in research and development and demonstrations of solar energy applications. The Federal Government participated in much of this work either as a partner in financing or as a partner in the scientific analysis. A list of the major utility solar projects would include the following:

1. Solar Total Energy Project at Georgia Power Company.
2. 10 MWe Power Tower at Southern California Edison Company.
3. Chronar Photovoltaic Manufacturing at Alabama Power Company.
4. Pacific Gas and Electric Department of Energy PV USA project.
5. Electric Power Research Institute Point Contact Program.
6. Dish/Stirling electric generation project.
7. Carrissa Plains.
8. Sacramento Municipal Utility District Solar Project.

The first two projects on the list, both considered demonstration projects by most investigators, used $200 million dollars of DOE money. The DOE now has 123.5 million dollars to spend on solar research and has requested 71.2 million dollars for fiscal year 1988.

Since fossil fuel prices have fallen and the Federal Government needs to control its spending, the Congress must place new attention on how much to spend on solar and renewable energy as well as which projects will yield the most benefits.

We can break the available projects in the solar arena into two categories; basic research and development, and demonstration projects. Georgia Power believes that the Federal Government should concentrate its spending on Solar in the research and development category.

First, we feel that most of these projects have high risks resulting from uncertainty surrounding the technical feasibility of many solar devices and uncertainty about the price of fossil fuels. We think that fossil fuel prices will eventually rise to levels that will make many solar devices economical. However, we have no way of knowing when this event will take place. We also believe, and I think most private enterprise firms believe, that the Federal Government would not permit a firm to gain large rewards that would result from a price run up in fossil fuels. A large number of techniques show great promise of delivering electricity or substituting solar energy for the highest cost electricity.

Second, demonstration projects can't yield anything except knowledge about scaling up existing technologies. Given the window of low fuel prices that faces us, we believe that we have time to develop more advanced technologies and then scale those up through demonstration projects. We believe that society will achieve higher returns from resources devoted to solar energy in this manner than it would if we used the resources to demonstrate existing technologies. After all, as new technologies develop in the next ten years, they will supplant existing technologies. Current demonstration projects will yield little or no information about scaling up these new technologies. We will need additional resources to do that. In the end we will have wasted resources to scale up antiquated techniques which we will not have used because of low fuel prices.

We believe that the DOE should have available at least 123.5 million dollars for solar energy next fiscal year. ie. the same level it has this fiscal year. They should direct these resources to several areas we think would yield the highest benefits to the U.S.

We need a better understanding of the physics of materials used to make photovoltaic devices. Georgia Power has a test underway that will yield side by side comparisons of the effectiveness of several types of photovoltaic devices. These devices range from highly efficient ones that cost a great deal to produce to low efficient ones that cost less. The test will yield information about the trade-offs between the various devices. We already know that costs of solar plants other than the costs of the solar cells require that the cells have greater than 15% efficiency. This means that the cell can convert 15% of the sun hitting it into electricity. Amorphous silicon cells cost less to produce per watt of electricity produced than any other available technique. But, they have the lowest efficiency. This means that one must have more of the other materials necessary to construct a solar device i.e., trackers, supports, land, etc. Professor Ajeet Rohatgi at the Georgia Institute of Technology does precisely this type of research. The DOE should continue to fund this research and others like it.

We need to do more basic research in the cell development process. Westinghouse has developed the dendritic webb technique for the growth of single crystal cells. They have made significant strides in throughput. However, they can, with funding, make strides in the next several years to increase throughput enough and improve the efficiency of the cells to get the cost of a module close to the $1.00/Watt target. Solarex, another manufacturer, has improved the manufacturing process of amorphous silicon modules, but still needs funding to continue to improve the efficiency of their modules.

The DOE should continue to fund the development of concentrators. Many solar thermal techniques could become feasible if we have available light weight inexpensive concentrators. Work on reflector structures and on reflector materials needs to continue. We should know more about lifetimes of reflective material, proper washing techniques and material composition for high reflectivity.

We can make great strides in the development of solar thermal energy by funding the development of heat engines using the Stirling cycle or the Brayton cycle. New designs using free piston Stirling engines have become available. Since many of these techniques use small modules, 25 kWe and smaller, both households and business can adapt them for use. And since the heat engines only require heat to run, we can use sources of heat other than solar energy as well. Thus, we could obtain backup power, or power at night from the same unit by heating it with a fossil fuel. We think that this hybrid form will yield the most benefits to utilities in the southeast because of the nature of our peak loads relative to peak insolation.

The South East region has a unique problem in the summer when temperatures and humidity reach high levels. Removal of moisture from the air accounts for much of the energy used by air conditioners. The removal of moisture from the air by using desecants combined with solar drying of the desecant may become a cost effective use of solar thermal energy in the next 3 to 5 years if funding of the research at places like the Florida Solar Research Center continues.

The Government should fund collaborative efforts between government agencies working on energy related studies, universities and private industry. For example, NASA does much work on dispersed energy techniques. We should have forums and agencies that can aid the transfer of knowledge gained from their experiments and designs for applications in the space to applications here on earth. The recent breakthroughs in superconducting materials will have an early application in solar energy because of their use in storage of electricity. The DOE should continue to provide funding to organizations such as the Solar Energy Research Institute and The Sandia National Laboratories to enable them to continue their research and to provide a place where researchers can share their information with each other.

I have attached two appendices to this presentation. The first contains a list and discussion of solar projects, programs and forecasts of the utility industry and the government. The second contains a list and discussion of Solar projects currently underway on the Southern Electric System.

Georgia Power Company believes that the United States has a window of opportunity, created by low fossil fuel prices, to develop high efficiency solar technologies. We believe that these devices will have high value when oil prices rise to $25-$30 per barrel in 1986 dollars. We cannot wait for prices to get that high before we act. We must do things now to prepare for those increases. However, we believe the United States would waste its research and development resources by spending them on demonstrating already known techniques or techniques that became available in the last few years.

APPENDIX A

SOLAR PROJECTS, PROGRAMS, AND FORECASTS

APPENDIX A

SOLAR PROJECTS, PROGRAMS, AND FORECASTS

Outside the Southern Company, whose projects are discussed in Appendix B, few major solar projects are being conducted by utilities. However, several installations are being funded or operated by private corporations or by Government agencies.

Most electric utilities contacted in a recent survey feel that the question is not if, but when, solar energy will be a viable option in the future. Based upon current learning curves and status of technologies, most utilities project that solar will be used in some form around the turn of the century. They feel that most of the technologies available today are immature and not economically competitive with other systems. All the utilities contacted, however, agree that the timing will depend on the economics of current forms of power generation. Therefore, solar should impact the western and southwestern part of the United Stated first and spread to the southeast later.

The utilities investigated are interested in solar for three reasons: for diversification, as a new source of generation, and for increased competitive advantage. Most utilities, over the past few years, have been looking for ways to increase profits, and solar energy holds promise since it is basically an end-use method of supplying energy.

Various utilities have contemplated the installation of experimental solar systems, but only recently, with the advance of some solar technologies, have they begun to consider solar as a source of competition in the future. If solar technologies are fully developed, and the projected advances are made, then competition for customers will become a reality in several utility service territories.

Following is a summary of current solar projects (thermal and photovoltaic), as well as abstracted versions of several important publications dealing with the larger topic of the national energy situation, and the specific topic of renewable energy sources in general, and solar energy in particular.

While the timetables presented in the various reports are not identical, all agree that solar energy will be a viable alternative around the turn of the century, opening up significant markets for companies with foresight in the 1980s.

APP A, SEC A1. CURRENT SOLAR THERMAL PROJECTS

Among utility companies, Southern Company is a leader in solar thermal research, Southern Company projects, as discussed in detail in Appendix B, include the Georgia Power Company's Solar Total Energy Project, Dish Stirling Project, and the "333 Building." Also included is Alabama Power's Montevallo Building. The only other significant utility involvement is on the west coast, where Southern California Edison has participated in or conducted several projects. SCE operated the 10 MW Solar One (central receiver) facility, and has taken a leadership role in efforts to advance the Dish/Stirling technology, following McDonnell Douglas' decision to terminate its stirling activity.

Among private corporations, the largest and most successful solar project in the U.S. is Luz Industries' 100+ MW parabolic trough system in California. SEGS I is a privately financed $62 million, 13.8 megawatt electric plant powered by 1,077,000 sq. ft. of collectors. The site is next to the 10 MW demonstration plant now operated by Southern Cal Edison in the Mojave Desert.

SEGS I contains 744 solar collector assemblies aligned in 140 rows. Each solar collector assembly consists of four 8 ft. x 172 ft. mirrored glass tracking troughs that reflect 94 percent of the desert sunlight. The reflected rays of the sun heat oil- filled black stainless steel pipes to 780 F to produce steam to make electricity.

As a follow-up to SEGS I, the company has built SEGS II, which is a $93 million, 30 megawatt power plant, developed and constructed under the direction of Cogeneration Natonal Corporation in association with Luz Corporation. SEGS II, on 150 acres of high altitude, high solar desert land, is an industry-leading solar electrification project, and the second phase of a 44 megawatt commitment to Southern California Edison Company. The site insolation (the intensity of solar energy per square meter) is one of the best in the United States. The SEGS II solar field consists of 485,000 sq. ft. of Luz Industries' prior generation design (LS-1), and 1,323,000 sq. ft. of 2nd generation design (LS-2).

Aside from SEGS I and II, the only other significant solar thermal project is the McDonnell Douglas Central Power Tower Heliostat Project, being operated by Southern California Edison in Barstow.

CURRENT PHOTOVOLTAIC PROJECTS

Several photovoltaic projects being conducted by Southern Company are descirbed in Appendix B. Unlike solar thermal, however, photovoltaic projects are being conducted throughout the United States.

Utility Projects

Florida: Florida Power & Light Co. is monitoring a 10-kW flat-plate array mounted on a single-axis tracker at its Flagami substation in Miami. The array, specially designed by FP&L to withstand hurricane-force winds, was placed in service last June for five years of testing. Several PV modules, including panels mounted on four dual-axis trackers, are being evaluated at the Southeast Regional Experiment Station at Cape Canaveral, operated by the Florida Solar Energy Center.

Massachusetts: Massachusetts Electric Co., a subsidiary of the New England Electric System, launched a $1 million R&D project with Mobil Solar Energy Corp. to install 2-kW PV arrays on 35 homes and commercial buildings in Gardner, Massachusetts, by mid 1986. Most of the solar panels will be connected to a single 13.8-kV distribution feeder for a two-year observation of transient response to voltage fluctuations on the feeder, the PV arrays, and their inverters, according to Donald Robinson, the utility's manager of energy conservation.

Also in New England, 24 PV modules totaling 4.3 kW are integrated with the roof of Boston Edison Co.'s innovative Impact 2000 house, a demonstration of the maximum use of solar and conservation measures.

Virginia: At Virginia Power, a five-year PV test program is planned for a three-acre site beside the utility's North Anna nuclear station. Timothy Bernadowski, supervisor of energy assessments, says three 25-kW arrays could be operating by the end of this year. One features single-crystalline silicon flat-plate modules, and the remaining two arrays will use polycrystalline cells--one mounted as a fixed flat-plate and the other on eight low-profile tracking pedestals. Performance data acquisition and analysis will be provided by Sandia under a joint PV testing program funded by DOE and EPRI. After a year of baseline testing, the utility plans to vary the panels' tilt, tracking orientation, and other parameters for another four years of tests.

Texas: The Austin, Texas, municipal electric system is building a $2.8 million test program with a 300-kW array. The single-axis tracking flat-plate system is scheduled for at least one year of testing. Elsewhere in Texas, an 18-kW flat-plate array feeds a battery bank for the uninterruptible power supply of El Paso Electric Co.'s Newman combined-cycle station.

New Mexico: New Mexico's terrain makes photovoltaics the power supply of choice for certain applications. Some 18 dozen 800-W modules power water pumps throughout the state, thanks mainly to generous tax credits. A 100-kW system is operating at Lovington on the grid of the Lea County Electric Cooperative, Inc., as part of the DOE-EPRI test program. The Southwest Region Solar Experiment Station is testing a 40-kW unit at New Mexico State University that is connected to the El Paso Electric grid.

The solar experiment station is also testing 120-W and 1.2-kW modules. In Santa Fe, a 2.8-kW residential array is tied to the Public Service Co. of New Mexico distribution system.

Arizona: Arizona Public Service Co. has monitored a 225-kW tracking, concentrating PV array at Phoenix's Sky Harbor Airport since 1982. The utility also monitors the performance of a 4.4-kW residential system that has operated virtually trouble-free on a Yuma home since late 1982.

Arizona Public Service is planning a five-acre test center at its oil and gas-fired Ocotillo plant near Tempe. The project calls for long-term evaluation of up to 100 kW of PV modules from five or six different manufacturers beginning next year.

California: San Diego Gas & Electric Co. is undertaking a technical and market study of a planned 37-townhouse demonstration of rooftop solar modules near Carlsbad. The project is a joint venture of home developers and a PV distributor. Six of the townhouses will be equipped with performance data recorders supplied by Sandia, which will also provide a weather monitoring station.

SDG&E installed a 2-kW rooftop unit on company-owned residential property adjacent to its Del Mar substation and, in addition to that unit, monitors the performance of a 16-kW array mounted atop a local convenience market.

SMUD PV 1, operated by Sacramento Municipal Utility District, is the world's first commercial central-station photovoltaic power plant to be built and operated by a utility. Located 25 miles southeast of Sacramento near the Rancho Seco site, it supplies energy to 400 to 500 homes.

The most extensive PV R&D effort by any utility is that of PG&E, which has both independently and in cooperation with EPRI operated and monitored numerous systems at its San Ramon engineering research laboratory for several years. About 40 modules are operating, including some 30 flat-plate systems.

In addition, a Varian Corp. 175-W concentrating (1000 x) module, using gallium-arsenide cells, has recorded efficiencies as high as 16.9% at San Ramon, while a 2.6-kW single-crystal silicon concentrator (33 x) module mounted on a Martin Marietta Corp. two-axis tracker has generated 13.75 MWh in three years of operation. PG&E is also testing thin-film solar cells from several manufacturers, reporting some performance degradation in these first-generation thin-film devices after as little as two months of testing.

Elsewhere, the northern California utility plans to monitor at least three customer-owned PV arrays beginning late this year; power ratings on these systems range from 2 to 20 kW. The 6-MW Arco Solar central station demonstration on the Carrisa Plains is already providing important data for the PG&E analysts. PG&E recently began its own conceptual design for a megawatt-scale central station facility, which it may someday decide to build.

PG&E also cosponsors, along with SCE, EPRI, and DOE, continuing R&D by Westinghouse on the dendritic web method of producing high-quality silicon sheet for lower-cost solar cells. PG&E, which has supported the dendritic web program since 1980, has taken delivery of about 80 modules made from sheet silicon, installing 2 kW atop the Veterans Memorial Building in Davis, with the rest going on test stands at San Ramon.

PG&E has promoted the concept of Photovoltaic Utility Scale Applications (PVUSA) to move large scale, modular PV systems toward economic feasibility. This year's federal budget includes a line item for a $40 million, five-year PVUSA program (50% cost share), with EPRI as a major cosponsor. Significant systems, from multiple competitors, will be tested.

Private Industry Projects

PRIVATE INDUSTRIAL PROJECTS

Arco Solar has become the largest industrial force in PV development. Within eight months in 1982, the company built a 1-MWp flat- plate power plant on 20 acres of SCE land adjacent to SCE's Lugo substation near Hesperia in the San Bernardino mountains east of Los Angeles. The single-crystal silicon cells are contained in some 27,000 modules mounted on 108 dual-axis computer-controlled pedestals that track the sun.

Since the system came on-line, the plant's capacity factor during peak hours in summer has been above 60%. Combined with unattended operation, low maintenance expense, no water requirements, and no air emissions, the potential for photovoltaics is evident.

Not content with 1 MW, in late 1983 Arco Solar began construction of a 6.5-MW plant and substation on 160 acres of PG&E land on the Carrisa Plains east of San Luis Obispo. The first phase of installation consisted of 756 two-axis pole-mounted trackers, each containing about 5 kWp of crystalline silicon cells with laminated glass reflectors to boost power output.

The modules feature an improved square cell design to increase packing density and boost module efficiency from about 9% to 11%. A novel field installation technique permitted construction of a plant four times that of the Lugo site in approximately the same amount of time. Arco Solar later added 43 trackers supporting larger module panels without glass reflectors to bring the system capacity to 6.5 MW.

In July 1984 a 1-MW field of Arco Solar modules mounted on low-profile horizontal-axis trackers was installed adjacent to the Sacramento Municipal Utility District's Rancho Seco nuclear plant under a program funded by SMUD, DOE, and the California Energy Commission. Since then, a second 1-MW system has begun operations.

APP A, SEC B. STRATEGIES OF OTHER UTILITIES

Utilities typically do not have a stated strategy associated with their solar research plan. They have, however, looked at the potential loss of market associated with solar products becoming a reality, and they have investigated the rising cost of electric power in terms of the potential for making solar generation economically viable in their service territories. Four utilities that do have solar strategies are PG&E, the City of Austin, TVA, and Arizona Public Service.

PG&E is committed to a significant portion of its future generation coming from renewable resources. PG&E's initial ventures into solar generation were a result of the Public Service Commission of California forcing all utilities in the state to have a stated portion of their generation supplied by renewable energy. PG&E, however, has advanced this philosophy and has developed a research and development program over a wide spectrum of solar technologies, with significant human resources allocated to research. Recently PG&E developed the concept of PVUSA, which is a program designed to prove the viability of photovoltaics in a utility environment. While PG&E has no stated strategy, its plans indicate a strong emphasis on solar as a part of the product line for the year 2000 and beyond.

The City of Austin also has no formal strategic plan for solar energy; however, it has established a number of objectives for solar energy:

- To install 40 MW in central station photovoltaic arrays by 1995
- To lease photovoltaic packages for residences and to monitor these systems to determine economic viability
- To monitor and take part in research and development associated with solar thermal activities
- To install demonstration systems in various solar technologies to determine their applicability
- To monitor other solar technologies as they become available.

The City of Austin has based all its installations on economics, and is projecting a break-even cost of $1.00/watt based on current gas and oil prices.

TVA, a local utility, has no published strategy, nor does it expect to sell solar equipment. However, the Company does expect to install and operate solar equipment. It currently has a test facility for rating solar hot water equipment, and has installed a number of solar systems across the system.

Arizona Public Service, which does have a stated policy on solar energy, also has a solar test facility and has been installing PV as part of a five tracker test station that compares flat plate versus concentrators. It also operates about 200 kW, and is expected to participate in PVUSA through the Salt River Project. APS also is working with PG&E and DOE on Molten Salt Central Receivers, but seems to have little interest in distributed receivers -- a philosophy similar to that of the California utilities.

Most utilities that were investigated do not seem to have a directed policy on solar, and apparently have not decided whether solar will play a significant role in the future. It is apparent that in the development of a strategy a future position for a utility should be established, and that objectives should be generated that will move the utility toward that position.

APP A, SEC C. UTILITY RENEWABLE RESOURCE ALLOCATION (URRA)

The URRA was formed in 1985 to help fill the need of utilities to become more knowledgeable about applications of renewable energy resources. The organization is currently sponsored by EPRI, but may become independent. Utility membership stands at 25, with a number of non-member utilities participating on an information-only basis.

URRA's scope includes all renewable technology that can be incorporated into utility planning, but the two high priority areas are photovoltaic systems and municipal solid waste utilization. URRA's primary objective involves exchanging current information on selected technology, conducting informative discussions, and facilitating technology transfer, all toward the goal of assisting utilities that are considering or planning renewable resource plants.

Another objective is to provide utilities with EPRI-developed information. Related activities include analyzing utility requirements, developing strategies, and reviewing field experience. Meetings are held two or three times a year. SCS serves as the system member of the URRA. The SCS representative is J. T. Petty, Technology Assessment, (205) 870-6241.

APP A, SEC D. EPRI PLAN ABSTRACT

EPRI's Research & Development Program Plan includes the following information for each of EPRI's six technical division:

- Organization chart for the division
- Summary of the content, selected major projects, major changes from last year's plan, and other selected issues
- Division program matrix with planned expenditures
- Program deliverables matrix

The division program matrix summarizes each technical division's R&D program in terms of EPRI's strategic program elements. The work is described with divisional program elements unique to each technical division. Each divisional program element is represented by a three line title and a number to denote the planned expenditures. The relative priorities of divisional program elements are indicated by the highest priority element being in the upper left corner of each matrix, and the lowest priority element being in the bottom right corner.

The program deliverables matrix identifies each technical division's key deliverables in terms of EPRI's strategic program elements, but no priorities are implied by their order of appearance. A general category is identified on the matrix for each deliverable, such as computer program or prototype hardware information.

A major projects matrix displays all the projects in terms of the EPRI strategic plan. All of the projects are reassessed annually for compatibility with EPRI's evolving technical goals, strategy and priorities. Funding requirements, current state of implementation, desired degree of EPRI participation, cofunding arrangements, and timing are reviewed before committing to their initiation or continuation. About 75 of EPRI's 1000 active projects fall into this category, since 20% of EPRI's expenditures are for major projects. Most are cofunded by utilities, vendors, the government, and others.

Full demonstration and commercial introduction of many technologies of interest to utilities cannot be supported within EPRI's current funding expectations. Based on the 1986 expenditure budget, generation is by far the largest division of EPRI. This division is continuing and expanding its investigation of fuels, plant systems and performance, turbines, fossil plant life extension, and gasification power plants, and a number of areas related to nuclear power plants are being expanded, such as light water reactor safety, operation and maintenance, occupational radiation management, and plant constructability. Very little work is being doing at EPRI in advance nuclear systems.

The renewable resource generation area of EPRI is concentrating its efforts in the photovoltaic point contact cell, and EPRI has expanded its efforts significantly in its environmental control technology division to investigate further SO2 control. Storage of energy continues to be of interest at EPRI, and the compressed air energy storage system planned for Alabama Electric Cooperative has received additional funds in 1986.

EPRI is continuing to support the delivery of energy by funding research on a broad front. New efforts, however, are focused on metering, communications and load control, underground lines, overhead lines, and substations. With the renewed interest and expanded need for demand side planning, the utilization division has received a significant increase in funds. The Environmental Division has concentrated its efforts in the acidity deposition process, while the analysis and planning division has expanded its efforts in investment risk management. The total budget at EPRI has increased some $21 million, or approximately 7.7% for these new efforts.

E. JAPANESE AMORPHOUS SILICON PHOTOVOLTAIC PROGRAM

By the end of 1985, Japan had taken the lead from the U.S. by becoming the world's largest producer of photovoltaic modules. During that year, Japanese total output was 11 MWp (including 8 MW of amorphous silicon), rising 38% from 1984. The total 1985 U.S. output was 10 MWp (1 MWp amorphous silicon), falling 23% from the previous year. Japan's growth in PV module output during the 1980-85 period has been termed "phenomenal."

The amorphous materials program in Japan is sponsored by the Ministry of International Trade and Industry, and is a part of the Sunshine Project Photovoltaic Division. The goal of this project is to supply a considerable portion of Japan's energy needs with alternate energy technology by the year 2000. Major corporations involved include Fuji Electric, Mitsubishi Electric, Komatsu Electronics and Sanyo Electric. The New Energy Development Organization (NEDO) is the lead center for management of contract work. The Electro-Technical Laboratory, ETL, a government facility, is one of the largest research centers in Japan for materials research for electronics and electrical applications. ETL is contributing amorphous silicon research.

APP A SEC F. U.S.A. ASSESSMENTS

F1. OFFICE OF TECHNOLOGY ASSESSMENT REPORT

This section summarizes the OTA Report New Electric Power Technologies -- Problems and Prospects for the 1990s. Although the material has been condensed and edited, the opinions and concepts are those of the U.S. Government.

INTRODUCTION

During the 1970s, the environment within which utilities made investment decisions changed from a predictable continuation of trends to a maze of financial, regulatory, and technology considerations. As electric utilities face the 1990s, the experiences of the 1970s have made them wary of the financial risk of guessing incorrectly and overcommitting to large central station coal and nuclear plants. At the same time, the possibility of being unable to meet demand exists, causing growing concern as the next decade approaches.

Utilities had to pay, on average, 240 percent more for oil and 385 percent more for natural gas, in real dollars, in 1984 than in 1972. These price increases drove them to "back out" of oil- and gas-fired generation and in favor of coal and nuclear plants. Oil dropped from 16 to 5 percent in the utility fuel mix and gas from 22 to 12 percent between 1972 and 1984.

Utilities are now taking steps to increase their flexibility in accommodating future uncertainties. In addition to continued reliance on conventional technologies, supplemented by coal combustion technology enhancements to reduce pollution emissions and increase efficiency, utilities are considering a variety of less traditional options that include two groups of "new technologies" that have potential for sizable applications beyond the turn of the century. Despite long-term advantages, however, at the current rate of development very few of these technologies are likely to be deployed extensively enough in the 1990s to make a signficiant contribution to U.S. electricity supply.

The first group consists of technologies envisioned primarily for direct electric utility applications and includes integrated gasification combined-cycle (IGCC); large atmospheric fluidized-bed combustors (AFBC); large compressed air energy storage (CAES) facilities; large geothermal plants; utility-owned fuel cell power plants, and solar thermal central receivers.

The second group consists of technologies that are suitable either for utility or nonutility applications, and includes small AFBCs in nonutility cogeneration applications; small CAES; fuel cells; small geothermal plants; batteries; wind; and direct solar power generating technologies such as photovoltaics and parabolic dish solar thermal.

Lead-times being experienced by some early commercial projects in both groups of technologies have been longer than anticipated, partially due to the time required for regulatory review. Working closely with regulators and taking steps to ensure quality construction for the early commercial plants could greatly assist the achievement of shorter lead-times. Emphasis on smaller unit size -- 200 to 300 MW -- would facilitate these actions. Cooperative agreements among utilities, public utility commissions, and the Federal Government can provide another mechanism for supporting advanced commercial demonstration projects of technologies from both groups.

The contribution of new generating technologies is likely to be enhanced if utilities are allowed to enjoy the full benefits afforded to qualifying facilities under PURPA and if the restrictions on the use of natural gas in power generation are removed. The latter would allow the use of natural gas as an interim fuel during the development of "clean coal" technologies, and give utilities and nonutility power producers added flexibility.

SOLAR SYSTEMS

Photovoltaics. PV systems are being pursued in many forms. Each seeks some combination of cost and performance for the module and for the balance-of-system.

In a concentrator module, lenses focus sunlight received at the module's surface onto a smaller area of cells; all available concentrator systems follow the Sun with two-axis tracking systems.

A flat-plate module is one in which the total area of the cells is close to the total area of sunlight hitting the exposed surface of the module. Various mechanisms, such as mirrors, can be used to divert light from adjacent spaces onto the exposed surface of the modules. Flat-plate systems may be fixed in position or may track the Sun with either single- or two-axis tracking systems.

The parallel development of these two types of PV modules and systems reflects a basic technological problem: it is difficult to produce PV cells that are both cheap and highly efficient. Cheap cells tend to be inefficient; and highly efficient cells tend to be expensive. At present, two types of modules appear to be the leading contenders. One is the flat-plate module based on tandem cells made from amorphous silicon; the other is the concentrator module, probably using crystalline silicon.

Flat-plate modules using amorphous silicon are expected to continue to develop. But basic technical improvements must be made before extensive grid-connected deployment will occur. Efficiencies must be improved, and the performance of the improved modules must be established over time and under actual conditions.

Given the modularity of photovoltaic systems, the rated capacity of central PV facilities in the 1990s will vary widely. A typical 10 MWe PV plant might occupy approximately 40 to 370 acres, consisting of 500 to 1,250 arrays, each of which would be supported by a structure resting on some kind of foundation. If the arrays are to track the Sun, they would require a motor and other tracking equipment.

Operating availabilities of 90 to 100 percent are anticipated for the multimegawatt PV installation of the 1990s. This will be affected primarily by the number of PCSs required and their quality. Most operating large PV systems today are characterized by operating availabilities between 80 and 90 percent, usually as a result of problems with the PCSs.

Solar Thermal-Electric Power Plants. These plants convert radiant energy from the Sun into thermal energy, a portion of which is transformed into electrical energy. With some feasible combination of reduced costs and risks and improved performance, four systems could be deployed within the 1990s: central receivers, parabolic troughs, parabolic dishes, and solar ponds.

A central receiver is characterized by a fixed receiver mounted on a tower. Solar energy is reflected from a large array of mirrors, known as heliostats, onto the receiver. Each heliostat tracks the Sun on two axes. The receiver absorbs the reflected sunlight, and is heated to a high temperature. Within the receiver is a medium (typically water, air, liquid metal, or molten salt) which absorbs the receiver's thermal energy and transports it away from the receiver, where it is used to drive a turbine and generator, though it first may be stored.

Parabolic dishes consist of many dish-shaped concentrators, each with a receiver mounted at the focal point. The concentrated heat may be utilized directly by a heat engine placed at the focal point (mounted-engine parabolic dish); or a fluid may be heated at the focal point and transmitted for remote use (remote- engine parabolic dish). Each dish/receiver apparatus includes a two-axis tracking device, support structures, and other equipment.

With a parabolic trough, the concentrators are curved in only one dimension, forming long troughs. The trough tracks the Sun on one axis, causing the trough to shift from east to west as the Sun moves across the sky. A heat transfer medium, usually an oil at high temperature (typically 200 to 400 C), is enclosed in a tube located at the focal line.

A solar pond inhibits the natural process by which warm water rises to the surface and loses its heat to the atmosphere. A solar pond is designed with three layers of water, with an extremely dense layer at the bottom and the least dense layer at the top. This interferes with the movement of warmer bottom waters toward the surface. Salt is used to increase the density of the bottom layer, forming a brine, to the point where its temperature can go as high as 227 F. The heat in this bottom layer can then be drawn off through a heat exchanger, where the brine transfers its heat to an organic working fluid which in turn can drive an engine to produce electric power.

All of these technologies share a principal disadvantage in that costs and performance are uncertain. For that reason the chances for widespread commercial application for any one technology during the 1990s are quite small.

At present, the parabolic trough is the most mature of the solar thermal electric technologies, with commercial units operating, under construction, and planned. Nearly 14 MWe (net) of privately financed capacity already is operating in southern California at the Solar Electric Generating System-I (SEGS-I); an additional 30 MWe (net), the Solar Electric Generating System-II (SEGS-II), now is being built. Additional capacity -- 150 MWe or more -- may be added by early 1989, if the energy tax credits are extended in some form.

Two types of parabolic dishes may be deployed in the 1990s: the mounted-engine parabolic dish and the remote-engine parabolic dish. Each offers many design options. The primary advantages of the mounted-engine units are their high efficiencies, low water consumption, and ability to operate without supplemental fuel.

The largest disadvantage of the mounted-engine unit is the relatively high level of uncertainty about its performance, and the possibility that the engines may require an excessive amount of maintenance. Only three commercial-scale demonstration units -- at about 25 kWe (net) each -- had been deployed by May 1985, and few are scheduled to be deployed by 1990; no commercial installation yet exists, or is under construction.

The remote-engine dishes, like the troughs, enjoy the advantage of being used at present in a commercial installation. A 3.6 MWe system, built by LaJet, Inc., now is operating in southern California. Also, like the troughs, the remote-engine technology may use as few as one or two engines; engine-related O&M costs, therefore, could be much lower than those of the mounted-engine parabolic dishes.

But the remote engine technology is inefficient; much heat is lost as the heat transfer fluid is pumped from the collector field to the turbines. Also, the system has little storage capacity; electricity production, therefore, cannot be deferred for very long. And unlike the mounted-engine units, the remote-engine technology consumes sizable volumes of water.

Both dishes and troughs suffer from the same serious problem -- they lack the cost and performance certainty that can be gained only through commercial -size operations. This mitigates against private sector investment which is not in some manner accompanied by government support.

By virtue of the fact that commercial-scale systems now are operating for troughs and dishes, the level of cost and performance uncertainty will be considerably lower than the uncertainty associated with the central receiver and ponds in the 1990s. Between troughs and dishes, uncertainty will be lowest for troughs, highest for the mounted-engine dishes, and somewhere in between for remote-engine dish systems.

APPA A, SEC F2. NATIONAL ENERGY POLICY PLAN

This section summarizes the Reagan Administration's National Energy Policy Plan (DOE/S-0040). Although the document has been considerably condensed, the opinions and ideas were left intact, and are those of the Administration.

INTRODUCTION

The United States must be able to develop new energy sources and conservation technologies, which is done best in a climate of reduced government regulation, fewer controls, lower tax rates within a fair tax system, and a commitment to the principles of free international trade in energy.

Considering a broad range of factors, including environmental quality, domestic availability, and cost, it makes the most sense at this time for the energy sector to emphasize coal, nuclear energy, and conservation wherever they are economical.

Petroleum, natural gas, and renewable sources (ranging from hydro to solar) are all part of a balanced energy mix that will support economic growth. It will be the marketplace, rather than the Government, that actually makes the decisions about development pace for each one. In the past five years, the following situation has developed:

- Crude oil prices have declined.

- The United States is using energy more productively.

- Total U.S. energy production has reached an unprecedented high level.

- The worldwide oil cartel is under increasing pressure.

- The U.S. is less vulnerable to damage from disruption of fuel supplies because of lower levels of oil imports, greater diversity of supply sources, and the Strategic Petroleum Reserve (SPR).

The goal in energy policy continues to be that Americans should have an adequate supply of energy, available at a reasonable cost. The strategies are to maximize practical reliance on the free decisions of the entire populace, while maintaining public health and safety and environmental quality, and to promote a balanced and mixed energy resource system. This goal presupposes three objectives: energy stability, energy security, and energy strength.

At present, energy problems are not a destabilizing force in the national life and economy. Since early 1981, market forces have reduced real oil prices on the world market by more than 40 percent, and the cost of a gallon of gasoline or heating oil declined by about one-third relative to disposable income per capita.

Total domestic crude oil production has risen annually since 1981, and nuclear energy has surpassed oil and natural gas (as well as hydroelectric power) to become the second largest source of electricity in the United States. Nuclear power plants currently provide more than 15 percent of total electric generation, second only to coal.

At the end of 1980, the Strategic Petroleum Reserve held more than 100 million barrels of crude oil, equivalent to 17 days supply of the net imports for that year. Now, the SPR holds nearly 500 million barrels of oil, the equivalent of about 120 days of current net imports.

On the other hand, domestic reserves of oil and gas have been falling, and significant potential oil and gas reserves onshore and offshore are being delayed or foreclosed from exploration and development. In addition, new nuclear power plants have been ordered for domestic construction since 1978, and 75 nuclear plants scheduled for construction have been canceled.

Appropriate investment in research and development is fundamental to energy security. The Federal Government should not and cannot do the entire job, but it can help. Its energy R&D focuses now on all sources of energy--renewables, conservation, fossil, nuclear, fusion, and alternative fuels--as well as on the effects of energy activity on human health and the environment. It is willing to undertake precommercial stages of higher risk projects that show potential for large long-term benefits, but which would not be cost-effective for private organizations because of their inability to reap the benefits or because of the projects' high cost, uncertainty, or likely slow payoff. The decision as to the economic feasibility of the later, more expensive phases of R&D is always left most appropriately with the marketplace.

ENERGY MIX

The Nation deserves a future in which its resources are used effectively to strengthen the economy and security of the United States and the free world. The resources exist to make this a reality: fossil fuels, nuclear energy, solar and other renewables, an efficient electricity supply system, and conservation. Today's energy stability provides us the opportunity to build an expanded base of technical knowledge for resources of the future.

Oil and Gas. For the rest of this century, oil and gas are likely to remain the principal energy sources of the American people. They now provide about two-thirds of the commercial energy used in the United States, and they are projected to be furnishing more than half in the year 2000.

In addition to promoting a free-market economy and full deregulation of natural gas, the most vital component of Federal action is the timely development of oil and gas resources on federally managed areas of the Outer Continental Shelf. Federal OCS lands currently account for about 12 percent of all proved U.S. oil reserves and 19 percent of our total proved reserves of natural gas. The Administration opposes any moratorium on OCS leasing.

It is essential that the remaining Federal price controls on natural gas be eliminated and that the Nation continue to move toward a more competitive system of transport for this fuel. Natural gas is the only primary fuel whose prices remain under controls, with the price of about half of all gas production still regulated by the Federal Government. As a result, "old gas" (including that from many fields that started production well after the oil embargo of 1973-74) is not coming to the marketplace as it could. A considerable amount is irretrievably lost in this way.

Conservation. Energy conservation is an integral part of the "energy triad." It has proven to be the most expeditious way to reduce the need for new or imported energy resources, and now contributes more to balancing the national energy ledger than does any single fuel source.

Despite a 21-percent increase in the number of U.S. house-holds since 1973, total energy consumption in the U.S. household sector is almost the same as it was 12 years ago. Savings in the industrial, commercial, and transportation sectors are similarly impressive.

Coal. There is enough coal in this country to satisfy the Nation's current use rate well into the 23rd century. Coal accounts for about 80 percent of the recoverable fossil fuel resources in the United States. Conventional oil resources, on the other hand, make up only a small fraction of our known fossil resources.

A modern coal-fired power plant is cleaner than most older oil-fired plants. If regulations are made flexible enough to accept them, there are new technologies (such as fluidized-bed combustion and coal-gasification combined-cycle plants) that already offer the potential for excellent environmental performance--at lower cost and with higher efficiencies.

Nuclear. Nuclear energy is vital. It has the best safety record of any large-scale commercial energy technology in human history. It is the second largest source of electricity in the United States, providing more than 15 percent of the Nation's electricity needs. It is expected to provide more than 18 percent of the Nation's electricity during the 1990s.

However, nuclear power has lost ground as a future energy option. No nuclear power plants have been ordered since 1978, and some have been canceled during late stages of construction.

The Administration is pursuing a fivefold strategy to help make sure that nuclear power plants remain an available option. It has proffered specific legislation for licensing and regulatory reform; it is staying on track with the tightly scheduled, yet scrupulously careful development of high-level waste storage and ultimate disposal; it has focused fundamental R&D on programs that should contribute to greater safety margins, standardized plant designs, and more usable systems; it endeavoring to make the American public better informed about the "how" and "why" of peaceful nuclear power; and, it is working to remove barriers to technology and equipment exports that do not encourage the spread of nuclear weaponry.

Electricity. For most of the 20th century, the United States has led the world in the development and maintenance of a reliable, low-cost electricity supply system. Today the United States has a surplus of generating capacity; but this condition is likely to be temporary, given current expectations about future economic growth and concurrent growth in the demand for electricity.

The Administration believes that the best way to ensure timely and appropriate investments in the electric utility sector is to develop and promote an improved regulatory environment that increases reliance on economic competition--among utilities, among generation technologies, and among end-use technologies.

Renewables and Alternative Fuels. Renewable energy resources--now primarily wood and water--contribute about 9 percent of this country's domestic energy production, and could provide nearly 13 percent by the end of this century.

The Federal program in solar and other renewable energy research and development has addressed key, high-risk technical issues that will provide a scientific and engineering knowledge base for industry to develop renewable energy systems with greater efficiencies, longer life, and lower system costs based on advances in the use of new materials.

APP A, F3. DOE ANNUAL ENERGY OUTLOOK

This section summarizes the Energy Information Administration's Annual Energy Outlook, 1985 (DOE/EIA-0383). Although the document has been edited, the concepts are intact and are those of the EIA.

Barring unforeseen changes, no dramatic modifications to the U.S. energy picture are anticipated between 1985 and 1990. Between 1990 and 1995, only moderate increases in oil and natural gas prices are projected, with higher levels of imports for those two commodities resulting mostly from declines in domestic production.

As stimulative and restraining factors offset each other, end-use energy demand is expected to rise at an average rate that could be well under 1 percent per year between now and 1995. Technological conservation should continue. However, total demand for primary energy is projected to increase a bit more rapidly than end-use demand. Greater use of electricity--generated mainly from the coal and nuclear power that are more plentiful in this country--results in higher conversion losses. Overall, however, the size of the full "energy pie" is remarkably similar for 1975, for 1985, and as projected for 1995. Energy markets over the next 10 years are likely to be more stable than those of the 1970s.

The most important new characteristic of the early 1980s that is expected to affect energy markets during the next decade is the continuation of world-wide excess production capacity in oil, which affects all other forms of energy. There seems to be adequate justification to assume a lower range of future oil prices. Even by 1995, world oil prices are now assumed to remain well below the peak of 1980 when expressed in constant dollars.

Lower prices for the major forms of energy are expected to lead to lower levels of domestic energy production, but (because of conservation trends) to only moderate increases over current demand. Total U.S. dependence on net energy imports of all kinds is projected to grow from 11 percent of total energy consumption in 1985 to 20 percent in 1995.

At least two long-term trends may be assumed to slow the rate of growth in energy demand over the next 10 years:

- Expansion of the light manufacturing and service sectors will continue to replace traditional growth in energy-intensive heavy manufacturing.
- Slower population growth will affect end-use energy demand, particularly in the residential and transportation sectors.

One long-term characteristic experienced in the natural gas industry is not expected to recur in the forecast period: With the expiration of regulations that existed in the 1970s and early 1980s, the gas market has become more competitive, a situation that is expected to remain over the next 10 years. Increased competition and the large increases projected in competitively priced imports should result in only moderate changes in average natural gas prices over the next 10 years.

This document is based on assumptions regarding trends in the economy and in world oil prices. Between 1985 and 1995, real GNP is assumed to grow by an average of 2.8 percent per year in the base case. This rate is the same as the annual growth rate between 1974 and 1984, but slightly lower than the longer term growth rate of 3.2 percent experienced between 1964 and 1984.

The other major assumption is the range in the path of future world oil prices. This assumption has an important direct influence on both the demand and supply of oil, as well as on the prices of substitute fuels such as natural gas. Real oil prices are assumed to decrease from $27 (in 1985 dollars) per barrel in 1985 to $23 per barrel in 1988 and then to increase gradually to $30 per barrel in 1995 in the base case. The latter would mean a price of $50 per barrel in 1995 dollars, but this would be well below the 1980 peak of $44 per barrel in constant 1985 dollar terms.

Substantial growth in net energy imports is projected for the next 10 years (from 11 percent of total energy consumption in 1985 to 20 percent for the base case in 1995). Domestic energy consumption is projected to rise at a slower rate than total GNP because of continued improvements in efficiency and the relatively weak performance assumed for heavy industry. Total domestic energy production is projected to grow slightly between 1985 and 1995.

Primary energy demand is projected to increase more rapidly than end-use demand because of the greater use of electricity, which involves large conversion losses. Between 1985 and 1995, about 60 percent of the increase in primary energy demand is attributable to losses associated with electric utility generation and distribution. While primary energy demand is projected to increase by 1.2 percent per year between 1985 and 1995, the end-use energy demand (which counts only delivered end-use electricity and not fuels used in its generation) increases by only about 0.6 percent per year.

Future end-use energy prices are expected to be determined more by competitive market forces and less by producer-country price-setting and government regulation. Petroleum product prices are expected to follow the pattern of the assumed world oil price, dropping in real terms for several years before gradually increasing again. End-use natural gas prices are forecast to remain constant until 1990 before increasing in real terms through 1995. After 1990 natural gas prices are projected to increase faster than those of petroleum and refined oil products.

End-use electricity prices are projected to increase slightly until 1987 (as new plants are added to the rate base) and then to decline gradually in real terms (by about 1 percent per year). Coal prices are assumed to increase slightly in real terms between 1985 and 1995.

Oil is still projected to account for the largest share of total U.S. energy consumption, although the share represented by petroleum products is projected to continue its decline over the next 10 years. The petroleum share of primary energy consumption is projected to fall from 41 percent in 1985 to 39 percent in 1995 as its growth is expected to be lower than that of other fuels. Both the industrial and transportation sectors (the two major end-use energy consumers) are projected to show almost no growth in total consumption between 1985 and 1995.

End-use energy demand between 1985 and 1995 is projected to grow most rapidly in the residential and commercial sectors. Even in these two sectors, however, growth is expected to be only 1.2 and 1.3 percent per year, respectively--low relative to earlier experience.

Total domestic petroleum supply is projected to decrease during the forecast period as a whole, following a moderate increase in 1986 and 1987. A faster decline is expected during the last 5 years of the projection period. Domestic natural gas production also is projected to increase slightly through this decade and then to decline through 1995--partly because of a slower pace of exploration and development, and partly as a result of increased competition from Canadian imports.

Electricity generation capability is projected to grow over the next 10 years, but more slowly than electricity demand. Some combination of additions to existing capability (other than those currently planned), demand-management techniques, cogeneration projects, and other non-traditional sources of electricity generation could be needed if demand grows as projected. Most of the increased demand for electricity will be satisfied by new coal and nuclear plants currently under construction.

Increases in domestic coal production are projected to offset some of the decreases in energy supplied by domestic oil and natural gas. Coal production is projected to rise from about 890 million tons in 1985 to about 1,120 million tons in 1995, with most of this additional output to be consumed at electric utilities. Industrial use of steam coal and exports of coal are both expected to increase moderately over the next 10 years, but metallurgical coal use in the United States is projected to decline.

Although renewable energy sources are not treated explicitly in this analysis, their use is included implicitly in EIA's projections by assuming that some of the historic decline in conventional energy use (which was the result of the increased use of renewable sources) will continue throughout the projection period. In any case, growth in the use of renewable energy sources (which will probably consist mainly of more wood use in the residential and industrial sectors and more electricity generated from wind and geothermal energy) is unlikely to be a major factor affecting conventional energy use over the next 10 years.

Cogeneration may meet a significant portion of new industrial electricity requirements because of special incentives that are assigned to it under the Public Utility Regulatory Policies Act (PURPA): Surplus electricity generated through cogeneration can be sold to local utilities at favorable rates (at the utilities' avoided cost). Cogeneration also produces process heat for industrial services. The potential for more cogeneration projects exists, but many uncertainties surround them, including the future treatment of these projects by public utility commissions and the possibility of modifications to PURPA. Increases in cogeneration would probably result in the use of more natural gas and in less need for central-station electricity generation.

F4. NATIONAL PHOTOVOLTAICS PROGRAM -- DOE FIVE-YEAR RESEARCH PLAN (1987-1991)

This DOE five-year plan is designed to sustain the momentum of the growth of the PV industry while continuing to develop long-term options that show the greatest promise for practical applications. The plan is consistent with national energy policy, which promotes a balanced and mixed energy resource of insure that all Americans now and in the future will have an adequate supply of energy available at reasonable costs.

The plan is based on sound technical objectives that have evolved from years of research. It incorporates private sector participation and acknowledges the fact that industries ability to assume risk is limited. The plan not only provides mechanisms for reevaluation through continuing technical assessments and program reviews, but also incorporates a set of technical goals based on the performance and projected cost of all major system components. The plan is a balanced approach to photovoltaic research and development by addressing all the major areas of concern, including the most promising known technological options and the most innovative ideas.

The promise of photovoltaics to become a significant source of electricity in the United States lies in its many positive attributes. Photovoltaic systems tap a potentially large and secure resource--sunlight. They have a low environmental impact and cost little to operate. They are suitable in a broad range of applications and, regardless of scale, require short lead times for design, installation, and startup. Photovoltaic systems are modular, making additions to existing system simple and straightforward. All of these attributes recommend further research and development to build on earlier successes in improving the performance of photovoltaic systems and reducing the cost of electricity generated by these systems. This plan describes the critical research activities needed to produce continued progress towards fulfilling the promise of photovoltaics.

For 30 years, photovoltaic systems have been based on solar cells made of crystalline silicon, the material of the semiconductor revolution. Sunlight striking the solar cell liberates electrical charge carriers within the crystalline silicon that, because of the internal voltage, produces electric current, which is collected by a set of fine metallic lines on the surface.

In the previous Five Year Research Plan (1983), the primary research emphasis was the development of promising new approaches to photovoltaic cells--such as thin-film and multijunction concepts. This research emphasis, which remains in this Five Year Research Plan, is vital to the success of photovoltaics as a viable partner in the nations' energy mix, especially as concerns one of the largest and most important potential photovoltaic markets--electric utilities.

The diversity among electric utilities and their uncertainties over future capacity implies that photovoltaics will become a viable option to different utilities within different time frames. This five year plan is based on achieving widespread adoption of photovoltaic technology by the utilities; the long-term technology goals reflect this objective. However, there is a role for photovoltaics in many utilities at higher module costs than the long-term goals.

In the next decade, utilities plan to install more than 8000 megawatts of peaking generation plants. The levelized energy costs for these plants are expected to be at least 100% higher than the costs used to derive the long-term goals for photovoltaic technology. Photovoltaic systems could then be competitive, during daylight hours, with such conventional plants at correspondingly higher system costs and therefore earlier in the process of technology development. This potential, near-term (early 1990s) utility market is important for photovoltaic technology; it offers the transition necessary to support industry until the long-term objectives are achieved. And for some utilities facing the challenge of increasing near-term peaking generation requirements, photovoltaic systems may offer a new energy option and an energy opportunity.

As the technology matures, electric utilities are developing a growing confidence in photovoltaics. Some are doing their own research on cells, modules, and hardware. Others are evaluating components, systems, and large-scale designs. Some are buying large amounts of photovoltaic power through third-party arrangements. And others are even making significant investments by installing large photovoltaic systems.

The last decade has seen photovoltaics become a technology with great potential. A new industry has emerged, and federally financed research, under the direction of the National Photovoltaics Program, has spurred significant technical progress. The program has paid particular attention to the planning process; it has involved electric utilities, industry, and universities in the development of its plans. What was originally a technology applied solely to space has now been applied to terrestrial uses. Two new concepts have originated that promise to take PV to a position of importance in our nations' energy future: new thin-film technologies and concentrators. The program has made major strides toward its goals and there are sound technical reasons to expect that photovoltaics will make a contribution to energy in the United States in the near future (five to ten years) as well as a significant contribution in the more distant future. For example, crystalline silicon modules are reaching 15% conversion efficiency, are stable over long periods, and are being used for many applications that are economically justified, including space, consumer electronics, and remote power sources.

The major impact of photovoltaics, however, will be on utility, grid-connected applications, representing a major challenge to U.S. scientists and engineers. Commensurate with significant progress in the technology, utility skepticism of the 1970s towards photovoltaics changed to guarded interest in the 1980s and, more recently, has become a rapidly expanding interest. Dozens of experimental utility installations, the largest being 7 MW, and thousands of smaller applications validate the reliability and feasibility of photovoltaic systems. While these installations are based almost entirely on crystalline silicon technology, one electric utility recently fielded an experimental, 100-kW photovoltaic system using a thin-film technology.

Among the accomplishments of the first decade was a five year research plan, completed in the Spring of 1983. That plan provided a focus on high-technology research and resulted in several important achievements in the technology. For example, the conversion efficiency of laboratory produced cells increased from 18% to 22% using crystalline silicon and from 99% to nearly 13% using thin-film materials. In addition, module life expectancy increased to approximately twenty years. Numerous techniques were developed to increase the efficiency of cell and module production. Industry adapted these techniques effectively, reducing module costs to less than $500 per square meters. As a result of these advances, the cost of photovoltaic electricity decreased from an estimated $1.50 per kilowatt-hour in 1980 to approximately 33 cents per kilowatt-hour today. (The long-term goal of this research plan is 6 cents per kilowatt-hour.)

The current five-year plan continues the work begun in the first five year plan. It emphasizes that the National Photovoltaic Program's role is to support the fundamental research and development necessary for a basic understanding of photovoltaic materials and devices. To this end, the program will maintain and increase its partnerships with industry, electric utilities, and universities. This should spur the development of the technology an assist the growth of the industry, helping photovoltaics to enter the bulk power market and the mainstream of American energy production.

The research plan has three principal areas: materials and devices research, module research, and systems research. The plan assumes partnerships among the government, photovoltaic industries, electric utilities, and universities. Commensurate with federal policies and the interests of the partners, the government assumes the primary role in materials and devices research, photovoltaic industries assume the primary role in module research, and the electric utilities have the primary role in systems research. The nation's universities will provide important contributions to all three principal research areas; especially in the training of scientific and technical manpower needed for the photovoltaic future.

This plan emphasizes materials and devices research, especially the development of promising new thin-film and multifunction concepts. A fundamental effort will continue in materials and devices research to explore the frontiers of understanding crystalline silicon, the technology that United States industry so successfully exploited for use in space as well as on earth. The plan also emphasizes the development of concentrator photovoltaic cells and modules, a technology appropriate for the sunniest region, principally the Southwestern United States.

By implementing this plan, the National Photovoltaics Program intends, in the long term, to establish photovoltaics as a significant contributor to the nation's energy supply. The program also expects to help maintain the momentum in the growth of the photovoltaic industry while continuing to develop those long-term options that show the greatest promise for practical applications in the electric utility market. The program expects this industrial growth to continue as the technology progresses toward its long-term goal and as industry identifies and develops new and different markets.

The National Photovoltaics Program acknowledges the importance of participation by the private sector, yet accepts the fact that industry's ability to assume risks is limited. The program intends its research to be complementary to private sector activities to enhance industry adoption of successful research results.

The plan is realistic and flexible in its approach to research. It not only provides mechanisms for re-evaluation based on program review and assessments of the R&D, but incorporates a set of technical goals to focus and direct the R&D activity. This allows the program to optimize tradeoffs between cost and performance for the different photovoltaic options.

The National Photovoltaics Program expects the partnerships among the federal government, private industry, electric utilities, and universities to continue and strengthen. These partnerships establish the framework necessary for stimulating even greater technical progress. Only by drawing upon all of these national strengths can the United States expect to meet the energy challenges and opportunities ahead.

F5. NATIONAL SOLAR THERMAL TECHNOLOGY PROGRAM FIVE-YEAR PLAN (1986-1990)

As long term energy needs of the United States and the world will require the development of renewable energy resources. In the short term, this nation has an abundance of coal and oil; but this may not always be true. Eventually, alternative sources of energy will be required. More than half the nation's energy needs could be supplied by the sun's radiation, which is renewable, non-polluting, and free.

Solar thermal technology converts the sun's radiation into useful products such as electricity, fuels and heat. The market potential of solar thermal technology is immense since it can provide electricity for large population centers as well as for small, modular applications. Also, process heat can be supplied in a wide range of temperatures for a variety of industrial uses.

Solar thermal energy has been proven technically feasible at a series of experimental installations and its costs have decreased dramatically. Performance has increased steadily in the past decade and projections lead to economic competitiveness with fossil fuels and other renewables in the mid- to late-1990s.

Solar thermal technology utilizes higher concentrated sunlight to produce thermal (or head) energy that can be used in that form or converted to electricity. Solar thermal technologies can supply energy up to temperatures approaching 1650 °C (3000 °F). This energy can also be stored thermally, thus extending operation into non-daylight hours. Hybridization, combining a solar thermal facility with a fossil fuel source, is also a useful option.

The basic building blocks of solar thermal systems are relatively simple. Concentrators are arrays of concave mirrors or lenses that adjust in orientation during the day to maintain their illumination of a target as the sun moves through the sky. The target, or receiver, of the illumination from the mirror elements is usually a bank of tubes (blackened to increase absorption of the solar input) through which a fluid circulates and absorbs the heat. The fluid's temperature is raised many hundreds of degrees, depending on design and the desired use of the energy. Storage of the solar heat for cloudy or non-daylight hours can be as simple as placing the heated fluid into insulated tanks.

The three primary solar thermal technologies are central receivers, point-focus parabolic dishes, and line-focus parabolic troughs. All three employ the same principle of concentrating sunlight and are distinguished by the various mirror or lens geometries utilized. Central receiver systems use fields of two-axis tracking mirrors called heliostats to focus the sunlight onto a single tower-mounted receiver.

This Solar Thermal Technology Program Five Year Research and Development Plan discusses the planning process and describes in more detail the first five years of the long term strategy for the development of solar thermal technology. The overall strategy is to focus and structure the activities that should lead to broad economic competitiveness for solar thermal. The state of each of the technologies is first assessed to determine the characteristics of the next system that could be built. These are referred to as "current capabilities."

Cost/performance goals are then determined to allow solar thermal technology to compete in the free marketplace for electricity and heat production and appear to be technically achievable in the 1990s. The critical advanced components and development decisions are identified and finally, tasks addressing each of these are delineated.

The energy policy goals of the Nation are to promote efficient and economic use of currently developed energy resources and to increase the range of future technological options available to the private sector, thereby increasing the energy security of the United States. For renewable energy research and development, the National Energy Policy Plan emphasizes:

- Renewable energy technology options having the potential to make a significant contribution to the energy supply systems as a consequence of successful research and development

- Activities that can be most effective in advancing technology towards the performance objectives most critical to realize that potential

- Generic materials science to support industry development of reliable and efficient systems

Consistent with this policy, direct federal funding responsibility for all renewables is generally focused in areas of basic or applied research where incentives for and availability of private investment are severely limited or nonexistent. As technologies develop and become more refined, the private sector is expected to assume increasing responsibility for technology development in response to the greater perceived returns. Well-conceived technology transfer programs are necessary to provide adequate information to facilitate informed decision making within the private sector.

As specifically applied to Solar Thermal Technology, recent analyses have identified both high energy contribution potential and high risk research elements where a Federal role in the development activities may be useful. Research activities that cut across all the solar thermal options, such as materials and concentrator development, are especially appropriate.

An effective collaboration between industry and the federal government is critical to the success of the Solar Thermal Technology Program. Industry (suppliers and users) will benefit substantially from government-sponsored research and development of the technology. In return, industry's cooperation and capability will help to expedite the solutions to the problems facing solar thermal technology. The elements of this informal relationship include:

- Federally funded research and development into areas with significant long-term benefits

- Cost sharing between industrial teams and the federal government

- Government-provided test facilities for component testing

- Technology transfer activities

Industry devotes most of its efforts in the more developed and cost effective technologies, while federal efforts are concentrated on promising, but more remote options and approaches.

For a given application, there are many parallel approaches with potential for technical and economic success. Some of these concepts appear to have reached a level to warrant major involvement by industry, while other areas are at the opposite end of the research spectrum, having long range interest only.

Solar thermal technology will have significant applications and early market penetration well before achieving the long-term goals. Such intermediate term goals are based on the projected costs of solar thermal energy, which are thought to be attainable in that time period with further research and development. These five year goals may be sufficient to penetrate solar thermal markets to a depth that would sustain growth of the technologies. As the delivered price of solar thermal energy decreases, the number of potentially economically feasible applications will increase.

To date, the efforts of industry and the federal government have led to steadily decreasing energy costs from solar thermal systems. Continuing evolution of system components and designs will further decrease costs, increasing the number of potential applications. As volume production for solar components increases, economies of scale will be realized, resulting in further decreases in the cost of solar thermal energy.

The current solar thermal capabilities are defined as the best system that could be designed currently and confidently, and then fielded to close to full scale. These include:

- Central Receiver/Electric
- Dish/Electric
- Trough/Process Heat

Comparisons of the current capabilities with long term system and component goals show that progress will be required on all fronts to reach those goals. The component goals sum to the system-level costs required, but they are not unique in that respect. Other component goals with different values could also be used as long as they added up to the required system level cost. The goals must be, and are, representative of a feasible design allocation. The required quantitative advancements in capital cost and annual efficiency are only one aspect of the advancements required in solar thermal technology. Also required are the confidence in the technologies to perform as projected, high reliability, system availability, and low maintenance costs.

To assist in focusing the solar thermal technology program, the Electric Power Research Institute sponsored a technical workshop in early 1985 to develop a consensus within the solar thermal community on the state-of-the-art for solar thermal energy systems and to evolve strategies for future research initiatives. Involved in the deliberations were key representatives from industry, utilities, and universities, as well as program managers from the Department of Energy Solar Thermal Program and its research and development laboratories.

It was the consensus of the participants that solar thermal energy systems in their present state have indicated their technical capabilities and the potential to become economically viable options for renewable energy generation which will be required by the users in the 1990s and beyond. What is needed for solar thermal systems to attain their potential are well-focused development programs based upon prudently applied financial resources. This implies structured programs with development milestones that satisfy the following user requirements:

o Near-term benefit, goal-oriented technology development with an emphasis on central receiver electricity generation, dish electricity generation, and trough process heat production, the three technologies showing the greatest potential for reaching the quantitative program goals, and

o Long-term benefit, high-payoff research to reveal and explore innovative new concepts which can be nurtured into development thrusts of the future.

F6. SOLAR ENERGY RESEARCH INSTITUTE FIVE-YEAR PLAN (1987-1992)

LABORATORY MISSION

The Solar Energy Research Institute (SERI), a single program-dedicated laboratory operated by the Midwest Research Institute of Kansas City, Missouri, conducts research in the long-range development of solar energy technologies. The Institute coordinates and performs this research for the Department of Energy in direct support of the national energy strategy to achieve a balanced and mixed national energy resource system.

The mission of the Institute on behalf of the Department of Energy, is "to be the nation's primary federal laboratory for solar energy research and to perform functions assigned by the Department of Energy in research, development, and testing." SERI carries out its mission by conducting and coordinating research and development on solar technologies that private industry cannot reasonably be expected to undertake. This work advances scientific understanding and establishes a sound technological base, enabling the private sector to make well-informed choices among technology options. General guidance is provided by the National Energy Policy Plan; specific direction is provided by year-to-year authorizing documents.

To carry out its mission, SERI does the following:

- Performs basic and applied research in the physical, chemical, biological and engineering sciences pertinent to solar energy

- Performs applied research and exploratory and advanced development in the areas of solar thermal, solar electric, solar fuels and related technologies, and in the evaluation of the solar resources

- Conducts field management responsibilities on behalf of DOE, including program integration, planning, and managing complementary subcontracted research and development in accordance with approved research plans, at universities, in industry, and at other federal laboratories.

- Performs analytical research and technology evaluations to support solar energy research planning and to provide objective analyses of technical applications of research results.

- Conducts technology transfer an serves as a source of scientific and technical information on renewable energy to government user agencies and user industries.

- Performs solar energy research and related program management activities for other government agencies and other organizations with the concurrence of the DOE.

- Carries out collaborative research and development with universities and industry and fosters the development of cooperative research and development ventures with industry.

- Provides researchers from industry, universities and other federal laboratories with access to SERI's specialized facilities and equipment and opportunities for short-term research assignments.

SERI works closely with the other federal laboratories, and the university and industrial communities in fulfillment of its mission. Participation by laboratory, industry and university researchers in the Institute's programs ensures that program planning and development includes input from these areas and that appropriate audiences for dissemination of research findings and results are in place. Technology transfer to the private sector is an integral part of the Institute's mission to enable the private sector to make informed selections among available technology options.

Since its establishment, SERI has concentrated almost exclusively on supporting the DOE Renewable Energy Program and on developing its scientific and engineering research capability and management systems for the purpose. This dedicated approach has been effective in increasing SERI's value to DOE and in establishing SERI as the symbol of federal commitment to a high-quality solar research program.

In developing this statement of the context in which SERI will operate over the next fifteen years, it is SERI's intent to present a vision of the future of this laboratory and its environment which the reader can accept as being well within the bounds of present uncertainty. SERI senior management believes strongly in the importance and value of solar energy technologies to the U.S. economy, and has prepared the following perspective on the future as seen from the viewpoint of a laboratory that believes solar energy must, eventually, become a major factor in the domestic energy supply mix.

The General Environment: The domestic economy will continue to exhibit steady but unspectacular growth over the planning period 1987-2002. The bulk of this growth will be in the services sector. Hence, overall domestic energy demand will grow more slowly than the economy as a whole. This will apply to most of the developed countries as well. At the same time, economic growth in the less developed countries, although rapid on a percentage basis, will not be a major factor in increasing global energy demand over the next decade. Finally, public perceptions of the importance and good sense of energy conservation and the long-term desirability of personal and national energy self-sufficiency are unlikely to be altered over the next fifteen years. Thus, demands for energy supply driven by economic growth or radically changed patterns of consumption are not expected to influence world energy markets dramatically for a least the next decade.

The moderate rate of economic growth will be outstripped by the accelerated growth of scientific understanding and the opportunities for its application to problem-solving. Particularly important to SERI will be improved understanding of biotechnology, and of the physics of the ordered state (materials science and electronics). In addition, improved understanding of man's environment (toxics, acid rain, climatic change) will influence public concerns related to energy production, largely in ways that are likely to raise the real costs of the conventional energy supply technologies.

Although the last energy crisis was primarily a petroleum crisis, and although the present price/supply situation is forcing the U.S. to become increasingly dependent on foreign petroleum, present circumstances make the recurrence of such a crisis unlikely over the next 15 years. Not only does the Strategic Petroleum Reserve provide a cushion against supply "shock," but the diversity of global petroleum supply sources, the abundance of natural gas available to the domestic economy, and the demonstrated strength of the conservation option will work against the re-creation of such a crisis atmosphere. The more likely scenario is a gradual escalation of fuel prices, starting in the mid 1990s, orchestrated by the petroleum exporting countries. The prolonged period of relatively depressed prices will, in the near term, reduce domestic investment in petroleum exploration and supply, but will not lead to public pressure for intervention until the late 1990s.

On the other hand, although the U.S. has never before experienced persistent problems with electricity supply, issues associated with electricity generation and delivery are likely to require an increasing level of attention over the planning period. These problems will result from major structural changes underway in the electricity industry at a time when there is substantial excess generating capacity and substantial uncertainty as to projected demand for electricity. The situation tends to retard large capital investments in generation and storage capacity (favoring instead smaller investments in peaking-type facilities) and will likely lead ot a decline in the overall reliability of our electricity supply system toward the end of the coming decade.

Although unlikely, several "surprise" scenarios are possible in the next 10 years. A period of rapidly increasing world oil prices due to a cut off of Middle Eastern oil; abandonment of nuclear energy due to a second Chernobyl-type episode; or regulatory limits on coal use, due to future environmental restrictions. These scenarios reinforce the point that forecasting a period of relative clam does not alter the value of having available a diverse set of energy options. Thus, the U.S. takes a substantial risk if it is less aggressive in pursuing alternative energy R&D.

The Laboratory Environment: The Solar Energy Research Institute will remain a government-owned, contractor-operated research and development laboratory throughout the planning period. The primary focus of SERI work will be the development of economically viable technologies to convert solar energy to marketable energy forms. SERI is, and will continue to be, the primary tangible evidence of the Federal commitment to solar energy R&D.

Consistent with its role as the lead laboratory for solar energy research, SERI will respond to challenges to become an integral part of the DOE laboratory system as well as to strengthen its interaction with industry and university users and performers. Recent patent legislation should increase SERI's ability to strengthen these interactions. In addition, concerns as to the health of the solar energy industry over the coming decade are likely to cause SERI to focus more attention on the international arena, both as a potential marketplace and as a source of competition for American history.

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SERI's ability to strengthen these interactions. In addition, concerns as to the health of the solar energy industry over the coming decade are likely to cause SERI to focus more attention on the international arena, both as a potential marketplace and as a source of competition for American history.

Continuing pressure on budgets will place a premium on cost-effective, efficient management of solar R&D programs, but the history of progress and the prospects for improvement of these technologies will provide compelling justification for continuing Federal support. The course of recent events, depressing prices and reducing levels of investment in the energy marketplace, suggests that consideration be given to setting more ambitious cost and performance goals (to be met at a point further in the future) for solar technologies. This implies that choices will need to be made as to which technology development paths to pursue. As the central laboratory for all solar programs, SERI will play a more active analytical role in support of such DOE decision-making.

Consistent with fulfillment of its mission, and utilizing its planning assumptions as background and rationale, SERI anticipates several strong activity trends emerging over the fifteen year period: filling the gaps in the technical scope of the Institute's science and technology activities as needed to support development of the solar technologies; consolidating the technical planning and analytical support capabilities needed in making the proper choices in advancing the Nation's solar program; and expanding outreach to laboratory, university, and industrial counterparts. A strong thrust toward collaborative, cost-shared research with the private sector is a key to this effort, as is attracting participation of research scientists from the universities.

As described in SERI's Institutional Initiatives, an analytical support capability is being established to support the DOE office of Renewable Energy in strategic planing, analysis and evaluation activities. To accomplish this support, SERI will acquire the analytical capability, and will develop linkages, internal and external, necessary for effecting this activity. Especially critical will be the establishment of linkages to the several SERI Technical Program Integrators/long-range planning groups serving the solar technology development programs. Working relationships with solar R&D users and performers will be fostered and planning inputs solicited from them on a regular basis.

F7. UTILITY DECISION MAKING IN THE 1980s: IMPLICATIONS FOR RENEWABLE ENERGY (REPORT BY THE RENEWABLE ENERGY INSTITUTE)

Staff and consultants of the Renewable Energy Institute (REI) conducted a review of the environment in which renewable energy technologies are being introduced for power production. Completed under contract with the Solar Energy Research Institute, the study revealed that variations in the utility market are extensive, and that the outlook toward renewable energy technologies will be influenced more by local utility needs, energy, and economic environment, and less by the fact that a renewable energy technology is involved. The fact that new renewable energy technologies have been introduced in a period of high planning uncertainty and rising energy costs has also had an important impact on the pace and character of that introduction.

This new environment for utility managers and regulators means that technology attributes such as first cost, modularity, peak matching, and demand side management potential have increasing weight for utility decision makers. Finally, there exists a high degree of concern about how technology development is being conducted and the effect of national energy policy on the utility environment.

The unique characteristics of each utility's planning environment makes it difficult to identify categories of utilities that are likely to have similar reactions to renewable energy technologies (RETs). For instance, the type of utility ownership (investor owned, public owned, or rural cooperative) has less influence on technology decisions than local circumstances. In most cases, renewable technologies will not be either automatically accepted or rejected, but will be judged according to their ability to meet a utility's needs.

All electric utilities work within a complex set of planning elements that include load growth, generating capacity, reserve margins, fuel mix, cost of service, existing investment commitments, environmental and rate regulation, external review process of proposed utility investments, and more. These planning elements, combined with availability of indigenous renewable energy resources within the utility service territory, and the perceived technical/ economical status of individual RETs, defines utility interest in regard to the need and timing for incorporating any RET.

Review of the internal and external influencing factors suggests that market penetration of RETs, in the near term, will occur in niche markets where a favorable system planning environment, as well as internal and external pressures on a utility's decision making process, encourage the RET over other generating options. More widespread utilization of RETs in the utility sector will result from improved technical and economic viability relative to other technologies, and increased availability of performance data from existing utility applications and hands-on experience with the technologies as they are commercialized.

Uncertainty is a dominant element in today's utility planning. Some utilities recognize that renewable energy technologies (RETs) have the potential to help resolve or reduce planning uncertainties. In most cases, however, the positive attributes of the renewable energy technologies are outweighed by perceived technical and economic risks associated with their current level of development in the utility sector.

Diversity in the energy input mix appears to have value in today's uncertain resource planning environment. In response to energy supply and price fluctuations, utilities are reluctant to rely on any one fuel source, regardless of its current market price, abundant supply, or the acceptability of current environmental impact. From a technology standpoint, utilities are looking for reliable power sources with extensive performance records demonstrated in a similar utility operating environment. Economically, utilities prefer systems with predictable in-service capital costs and revenue requirements that have the potential for stabilizing or lowering electricity costs.

Renewable energy technologies have the potential for addressing many of the concerns associated with utility planning uncertainties. For the most part, RETs can be brought on-line in a relatively short period of time in small, modular units. They appear to have environmental benefits and regulatory support. And, the ability to contract with independent power producers allows utilities to bring RETs into their resource base and forego much of the economic risk of investing themselves.

At the same time, however, RETs are seen as adding to the risks facing utility decision makers because of their current technological and economic status, and means of deployment. Without adequately demonstrated performance records, utilities are skeptical about system reliability. The cost of owning and operating an RET is also a question to utility decision makers, particularly for those technologies that are still in a pre-commercial status. Finally, the advent of independently owned and operated RETs, in the views of utility decision makers, appears to have created additional uncertainty in the planning environment. Until utilities are assured of the ability of RETs to reduce planning uncertainties and risks, it is unlikely that utilities, on the whole, will pursue RETs.

Cost-impact to rate payers is given very high priority in utility decision making. The resulting utility and regulatory emphasis on near-term, least-cost planning tends to discourage investments in capital intensive systems like renewable energy technologies, although RETs may have potential for long-term savings. This situation also has negative implications for utility demonstrations of pre-commercial renewable energy technologies.

Over the past decade, the utility industry has evolved from a declining-cost business to one of increasing costs. As a result, rising retail rates for electricity have become a predominant concern for utilities, regulators, and consumers. Because of this, the cost of service has become one of the leading factors in evaluating utility investment options, and current utility planning includes supply and demand strategies that result in the lowest cost electric service in the near-term.

On the face of it, the prospects for RETs under near-term, cost-based analysis are discouraging. Utility investments in commercial RETs must compete on an economic basis with other demand management and generation options. Most RETs, in their current status, are seen as more expensive and less proven than conventional options and do not fare well under current utility economic evaluation. More long-term demonstrations and information on actual long-term cost of RETs, as compared with other supply options, are needed to overcome these perceptions.

Many utilities, however, see a potential role for dispersed use of renewable energy technologies by their customers as a means of managing load growth and postponing further central station power plant construction. However, the technologies must meet a number of requirements related to performance and cost before they are accepted in utility planning.

The traditional mode of providing adequate supply in large blocks of generation and marketing electricity to bring demand up to generating capacity no longer represents the utility's only option of meeting future load growth. Reduced demand growth and excess baseload capacity have been experienced by many utilities throughout the country. This situation results in higher retail rates for the smaller-than-expected customer base. At the same time, regulation (Public Utility Regulatory Policies Act or PURPA) provides incentives for the interconnection of non-utility owned power sources. Confronted with higher rates, large commercial and industrial customers may be motivated to bypass the utility's service and self-generate using cogeneration or renewable energy based small power production systems.

The key to beneficial incorporation of customer owned RETs in utility planning is the ability of the dispersed system to meet the needs of the utility and the power pool. Dispersed RETs will be encouraged by utilities only if they are seen to provide a reliable source of energy (and therefore do not require the utility to maintain costly back-up capacity), deliver electric or thermal energy on a competitive basis with centralized supply, and do not cause unexpected loss of load. Controlled penetration of dispersed RETs can help defer central station power plant construction; uncontrolled or unwanted penetration can adversely affect utility economics and capacity planning.

It is generally felt by utilities that government, utilities and vendors all have a role in technology development, but that these roles need to be well-coordinated for a new energy technology to reach maturity. Utilities feel that for RETs to reach commercial maturity, the relationship of the three groups must be modified, including re-establishment of government participation in technology demonstration and by determining the appropriate role of the independent power producer in technology development.

G. GAS RESEARCH INSTITUTE (GRI)

GRI has been in business since 1978. Its primary objective is to facilitate optimal use of natural gas in thr U.S. economy by developing projects that would remove major technical barriers. Approximately half of GRI's 1987 R&D program budget will be spent on end-use research. The $86 million will fund the development of new, more efficient end-use technologies to increase the competitiveness of gas in the residential, commercial and industrial markets. Gas-fired heat pumps, desiccant cooling systems, and industrial process equipment are technologies on the research agenda.

The key component of the GRI desiccant cooling package is a rotating wheel packed with a desiccant material to remove moisture from the unconditioned air stream. A second gas-heated air stream removes the unwanted moisture from the desiccant.

A substantial market for desiccant dehumidification is approximately 28,680 supermarkets. According to GRI, saturation of this market with this technology could reduce annual electric consumption by 6.5 billion kWh. As replacement energy, 21.2 Bcf of gas would be used to dry the desiccant material. Supermarkets have a high latent-to-sensible cooling load ratio, which makes them prime targets for desiccant technology commercialization. The gas industry views gas cooling as a means of increasing sales during its summer off-season. More than 40 units have been sold to 13 supermarket chains.

APPENDIX B

SYSTEM SOLAR PROJECTS

Appendix B

System Solar Projects

Appendix B contains descriptions and summaries of the solar energy projects and programs in which the System is involved. These projects are divided into three broad categories: solar thermal, photovoltaics, and coordinating projects. The objectives of each project, a description of the technical and business aspects of each project, and the results of and future plans for each project are included. The projects were reviewed by the Solar Strategy Committee to assist in developing the System solar strategy.

Section A

Solar Thermal Projects

Following are summaries of the projects conducted by the Southern Company that utilize solar collectors or reflectors to produce heat. The heat is then used for generating electricity (via steam turbine) or for commercial or residential heating or air conditioning.

Appendix B

Section A1

SOLAR TOTAL ENERGY PROJECT (STEP)

A part of the National Solar Thermal Energy Program, initially funded by DOE, and under the technical direction of Sandia National Laboratories (SNLA), the Shenandoah Project is the world's largest industrial application of the solar total energy concept. The objective of the Project is to evaluate a solar total energy system that provides electrical power, process steam, and air conditioning for a knitwear factory, operated by Bleyle of America, Inc. Solar energy generates a large part of the electricity and displaces part of the fossil fuels normally used to run the factory and produce the clothing.

When the STEP program was initiated at SNLA in 1977, the DOE specified the following program objectives:

1. Produce engineering and development experience on large scale total energy systems as preparation for subsequent commercial size applications.

2. Assess the interaction of solar energy technology with the application environment.

3. Narrow the prediction uncertainty of the cost and performance of the Solar Total Energy System (STES).

4. Expand solar engineering capability and experience with large-scale hardware systems.

5. Disseminate information and results.

Construction of the system was completed early in 1982, when operations were initiated under the management of the Georgia Power staff. Today, it is perceived that all of the above objectives have been met, and the solution of expected electrical, mechanical, and system problems have produced significant information for subsequent system designs.

Operation of this solar thermal system begins with circulation of a heat transfer fluid through the receiver tubes of 114 parabolic dish solar collectors. Solar energy is focused on the receivers by the collectors to heat the fluid to 750 F. The fluid is then pumped to a heat exchanger, where it boils water and superheats steam. The superheated steam drives a turbine generator, producing electricity.

Medium-pressure steam is extracted from the turbine for knitwear pressing, and low-pressure steam exhausted from the turbine is used to produce chilled water for air conditioning.

The fully operational solar system is capable of generating 11 billion Btu annually, or 11 million Btu per hour peak thermal energy. This can be translated into 400 kW of electricity, 1380 pounds per hour of process steam at 350 F and 120 psig, and 257 tons of air conditioning. Energy needs beyond the solar derived portion required by the Bleyle Plant are supplied by conventional sources.

Key experiences and issues associated with the technical operation of STEP are summarized below:

1. Significant Startup Anomalies

During the start-up phases, several mechanical type operational problems were encountered. Most were related to supplier and design areas and were not surprising in their magnitude, frequency of occurrence, or difficulty of solution. However, assuming by experience that all of these type problems can never be eliminated, it is suggested that the key experience to be conveyed by the STEP activity is the recommendation that strict formality and adherence to designer approval quality control procedures, startup specifications, and acceptance procedures be a key part of future projects.

2. System Hardware and Software Controls

The centralized architecture of the control system greatly complicated the software and did not provide the various equipment failure modes that made operation of the STEP extremely difficult and seriously degraded performance. This centralized architecture was the generally accepted control system architecture during the design phase. However, even with the selection of current architecture, poor operational performance was experienced due to inadequacies in the software, its complex arrangement, and poor documentation. Redesign of the control field control system with a distributed system has essentially eliminated all collector field problems. Coupled with planned changes in the BOP control system, STEP will provide the opportunity for achieving original STEP design objectives. A distributed control system should be utilized for future designs and full testing of subsystems software and integrated systems should be performed prior to installation. Complete control system hardware design and checkout documentation should be provided to the operators. A design/operator interface period should be planned in the schedule to be used for final start-up of the system and not to design and redesign the total plant system.

3. Environmentally Related Issues

Water related problems caused many equipment failures and excessive maintenance. Prototype testing for some of the failed equipment was performed in the dry Southwest climate which did not expose the components to some troublesome environmental issues. Operator error led to a major water contamination of the HTF. Field changes by the operations staff, with design assistance from SNLA, corrected most problems. Greater care should be made to specify environmentally protected equipment and rigid and formal acceptance procedures should be followed for future solar system designs.

4. Heat Transfer Fluid Performance

A significant amount of heat transfer fluid was required due to losses during operation; performnce was seriously impaired by improper useage of the HTF; and excessive operational manpower was required to operate STEP due to HTF anomalies. These were caused by initial HTF operating pressure data being incorrect or misleading resulting in design and operating pressures below the currently recommended HTF operating pressure. The HTF operating pressure has been increased by SNLA design changes and subsequent operations indicate the problem has been resolved. For future designs, care should be taken to insure that the properties of the new systems, components, materials, and designs are well defined by the suppliers and tested thoroughly by the user.

5. Thermodynamic Considerations

The steam temperature and pressure requirements of the Balance of Plant did not match the HTF temperatures attainable from the collector field. The cause was poor performance by the HTF; collector control and flow distribution problems; and excessive steam system pressure drops. The BOP was designed with the steam temperature and pressure requirements of a conventional power plant. A gas superheater, procured by SNLA, was installed by STEP Staff to raise steam temperatures to the level required by the turbine. Steam pressure has not been increased, but HTF pressure increases have dramatically improved maintainability and performance. Field flow anomalies remain unresolved. Future designs should review in detail this type operation, not only for STEP, but at other major solar operations.

6. Operational Electric Consumption and Manpower

Excessive operational manpower was definitely a problem at STEP, but it is debatable if excessive electric consumption can be called a problem. The cause of the excessive manpower utilization was poor performance of components, particularly HTF and an incomplete control systeem. But electrical parasitics will always be relatively high at STEP because of the small plant capability. With new energy conserving techniques and a reasonable size scale-up, it is believed that a STEP design can operate at parasitic energy consumption percentage equal to conventional power plants. For future commercial plant designs, manpower requirements and parasitics should be a key consideration in the design process and given the kind of attention that was given to the heat losses of the system.

7. Correlation of Energy Resource/Demand Schedule

Correlation of energy resource with the demand schedule is a problem for most solar systems. The cause is the hourly, daily, and seasonal variation of the sun and the weather. The concept and testing of STEP has provided some of the answers but has not solved the problem. Because, currently STEP is a cogeneration system with two fossil fuel sources, the plant is flexible enough to supply any combination of the outputs. The STEP plant can provide a useful output even when conditions are less than desirable. Oversizing of the solar plant and large amounts of storage may correct the problems in the future, but the time for economic parity with other energy sources will be extended due to the additional cost of storage systems.

STEP has been a tremendous success. Now, the overall project will advance to a new plateau.

Sandia should continue to support in a cooperative arrangement further system modifications and developmental testing. Projects under discussion include a new turbine, resurfacing of collector surfaces, reverse return flow, and added insulation in the collector field.

The system operational requirements have changed since the original design. Also, a significant lesson has been learned during operations - the extracted steam rate has a marked effect on power generation. A radial flow turbine, to replace the current axial flow turbine, would be more efficient and fulfill current needs better.

In 1987 a college accredited project will determine the merits of silvered acrylic film on five collectors compared to five collectors with the original aluminized acrylic film. The relative reflectivities and spectral distribution will be measured. Based on the results and a favorable cost-benefit study, replacement of the original film may be recommended.

In 1988 a reverse return flow experiment will be conducted on half of one branch. Operating history has shown that because the system has parallel flow in collector field branches the collectors at the end of each branch have inadequate flow. The merits of a system retrofit will be evaluated.

Earlier collector field heat loss studies have shown that the major loss is from the receivers. Tests have been initiated to reduce this loss by adding appropriate insulation.

The system will be optimized by conducting Sandia sponsored testing in 1987. These and other programs will enhance the producion of electric energy at the least cost per kWh. The total input will vary as a function of solar irradiation.

STEP is the cornerstone for visitor accommodations, training, and testing. Technical solar presentations and tours of STEP and other facilities are available to workshops, seminars, civic groups, professional groups, and others. Training and testing within STEP is ongoing and on several levels. College accreditation involves a curriculum with study of solar sciences, cogeneration, computer science, and economics. Numerous technical theses have been completed. A permanent building is scheduled to adequately cover these areas of interest and need. Delayed because of Plant Vogtle construction cost, construction of this facility is expected in 1990. With permanent facilities complementing the STEP program, there will be a place for young engineers, such as Engineers-in-Training and other assignees, to prepare for the opportunities provided by solar energy to the Southern System in the decade ahead.

The idea for the Solar Total Energy Project was accepted and brought to fact in order to demonstrate the merits of solar energy for industrial cogeneration. Today that has been accomplished. It is now the centerpiece for a broader program of enhanced system and subsystem operation, optimization of energy produced as a function of cost, a cornerstone for public relations, and an opportunity for young engineers to learn about solar energy.

Appendix B

Section A2

DISH/STIRLING

The Dish/Stirling (D/S) system, a new addition to the Shenandoah site, is a solar-to-electricity conversion system capable of producing up to 25 kW using an external combustion engine to provide rotational energy to the electric generator. The incoming solar energy is reflected and focused to the aperture of the engine by a concentrator made up of 82 flat mirrors (3 ft x 4 ft) attached to a support structure. The concentrated solar energy heats hydrogen gas that drives the pistons of the engine much like a steam engine is driven by expanding steam. The system is completely self-contained and can start up and shut down without a system operator. The system is directly connected to the Georgia Power grid.

This self-contained system includes a dish concentrator (750X), an externally heated 4 cylinder engine, and a 25kW(e) induction generator. Testing at Shenandoah has demonstrated high efficiency (approximately 30%), low maintenance cost potential, and the merits of hybridization using solar or fossil fuel to provide desired dispatchability.

The current status was reached by research funded by DOE; McDonnell Douglas Coperation (MDC); United Stirling AB of Malmo, Sweden (USAB) and others. The Stirling engine was invented in 1816 by a Scottish minister, Rober Stirling. United Stirling has developed and tested the Stirling engine in recent years for use in solar electric power production. In 1982 McDonnell Douglas Corporation initiated a study of solar parabolic dishes for generation of electricity. In June, 1983, MDC began development of the solar parabolic dish concept to collect solar energy in an 11 meter diameter dish that reflects the energy to a focal point, 6 meters above the dish, to produce electrical energy using a Stirling engine/power conversion unit. In November, 1983 MDC announced the signing of a cooperative agreement with USAB to jointly develop, manufacture, and market the D/S electric system. Four utilities, including GPC, signed agreeements to test and to help further commercialize the technology. However in June, 1986, MDC decided to terminate all energy activities. This created a void for this promising technology. GPC and Southern California Edison (SCE), who purchased the D/S licensing from MDC are trying to develop a mutually agreeable plan to do additional research leading to the commercialization of the Dish/Stirling. GPC must retain a license option for the Southern Company service area, the Caribbean, and South America as well as other business options in order to continue a venture with SCE.

There has been much support in industry and government circles for the Dish/Stirling as being the best solar thermal option for producing electrical power. Several U. S. firms such as, Cummings Engines, Solar Power Systems, and Mechanical Technology Incorporated are doing significant research. There is continued interest in Europe and a new interest in Japan. Someone will make a major commercial impact; it could be the Southern System.

The use of the Dish/Stirling can be terrestrial or non-terrestrial. In addition to the U.S., the ten nations having good market potential for solar electric generators in the 1985 to 2000 time frame are Australia, Brazil, Caribbean nations, Greece, Indonesia, Mexico, Saudi Arabia, South Africa, Spain, and Venezuela. The best non-terrestrial application appears to be space station power under U. S. Department of Defense contract.

The most important remaining steps are three-fold. The unit must be hybridized to approach 100% availability. The system must have a good statistical test with 40 or more units operated over a sufficient time frame to validate low operating and maintenance costs. The installed cost must be significantly reduced to make it competitive with conventional systems.

Appendix B

Section A3

GEORGIA POWER COMPANY 333 BUILDING

The Georgia Power Company's Corporate Headquarters features a comprehensive solar energy demonstration project in commercial solar heating, cooling, and domestic water heating. The building was designed to optimize the use of solar energy at minimum additional first cost to the project. Its solar energy system is an international landmark. This building also features an outstanding energy conservation design and many innovative energy management systems. The solar energy system was completed in 1981 at a cost of $1.3 million. DOE provided funding in the amount of $565,000 with Georgia Power contributing the balance. Georgia Power operates the system and bears the annual operating costs.

The "333 Building" has outstanding potential for rapid and widespread commercialization, and its concepts are available to other solar designers, architects, engineers, and commercial building owners. The visibility of the project (most notably the passive solar design of the south wall) to more than one million interstate auto travelers per year provides the public with a realistic illustration of the advantages of the marriage of conservation and solar energy.

The solar energy system collector array consists of 1,482 parabolic trough (line focus) concentrating collectors arranged in rows of five to eight each, running north and south. Each collector has an aperture of two feet and a length of eight feet, making the total area of the array 23,712 square feet. The troughs are divided into 50 independently controlled groups for tracking the sun from east to west. The tracking is controlled by radiation sensitive phototransistors on each of the 50 groups. The system also consists of over 60,000 gallons of hot water storage and a 250 ton absorption water chiller. During the summer months, the heat accumulated by the solar collectors is utilized to power the absorption chiller to reduce electrical demand. In off-peak months the solar collectors provide heating for the domestic hot water and building heating systems.

The system operated at approximately 20% efficiency through mid 1985. Piping and system modifications were made at that time, and system efficiency is now running around 30%. Operating and maintenance costs for the system are now averaging $10,000 per year. Energy produced by the system each year is equivalent to $30,000 in kwhr sales for a net savings of $20,000 annually. Over the last five years the system has provided approximately 10% of the 333 building's energy needs.

In past years the electrical demand peak for the building has occurred during periods of severe haze, basically eliminating any peak demand reduction due to the higher system temperatures required for absorption cooling. Total heat collection has also been less than half of the projected delivery. Factors contributing to degraded performance are:

(1) Less than expected levels of insolation as a result of prevailing weather conditions.
(2) Light sensitive tracking as opposed to time of day tracking.
(3) Poor collector efficiency at temperatures required for absorption cooling.
(4) System limitations as a result of failure to allow use of lower quality heat (better efficiency in summer for domestic hot water when temperatures required for absorption cooling cannot be reached).

Future plans for the system call for continued operation of the system to enjoy the energy cost savings avilable. System modifications and improvements will be considered on an economic basis. Modifications to allow a reduction in the building's peak demand are being considered.

Since the solar energy system at the 333 Building provides a net savings, it is implied that continued operation of the system should be a part of any Southern Company solar strategy. The positive aspects of this demonstration project need to be emphasized more. Consideration should be given to an objective of increasing R&D funds to further refine and improve the testing and operation of this system. Evaluation of the future costs of such a system should be made to project parity with conventional systems.

Appendix B

Section A4

ALABAMA POWER COMPANY MONTEVALLO BUILDING

In 1975, Alabama Power Company (APC), as part of a complete energy conservation program to promote the utilization of solar energy heating/cooling systems, completed the design of a solar-assisted, heated and cooled district office building located in Montevallo, Alabama. The design team which was assembled included corporate personnel, an architectural firm, an engineering firm, and other consultants.

The following are the major objectives originally established by the design team:

1. Establish design criteria and design evaluation procedures for solar powered systems.
2. Demonstrate the effectiveness of an integrated solar design team effort in satisfying project requirements.
3. Establish a data base through instrumentation to be used in developing a viable solar energy industry.
4. Develop solar component and system computer modeling techniques employing meteorological data collected through this project.

5. Implement a solar energy demonstration project to increase public and private awareness regarding future impact of solar energy.
6. Obtain a working knowledge concerning the requirements for the operation and servicing of solar-powered systems.
7. Demonstrate the architect's and consulting engineer's roles in the energy conservation movement through innovative building design concepts.
8. Provide leadership for the electric utility industry and its customers by establishing energy conservation as a design imperative.
9. Establish a data base to be used in developing and evaluating load leveling and management opportunities for electric utility customers.

The APC Montevallo district office solar project serves three basic functions: (1) fulfills the requirements which have been established for district level operations; (2) serves as a demonstration regarding the utilization of an integrated commercial solar heating and cooling and hot water heating system; and (3) serves as an energy conservation research project which will provide data to be used in expanding the company's load research data base.

The building is used for typical district office operations within the APC service area — namely, to satisfy functional space requirements for the accounting, marketing, operating and appliance service departments. Provisions have also been made for displaying appliances and an auditorium is available for company and customer training programs and also for public and civic activities.

Based upon the Montevallo District office solar system heating and cooling operation since 1975 and the data collected during that period, the following recommendations and conclusions have been reached.

1. Active solar heating and cooling in a commercial environment in the Alabama climate, while technically feasible, doesn't appear to be economically justifiable. Solar cooling technology requires a significant amount of R&D before it can achieve even moderate penetration levels. Year-round heating loads such as water heating are, of course, more economically attractive.
2. The 'drain-back' method of protecting solar systems from freezing is the best method of freeze protection. This concept offers advantages in terms of initial cost, operating efficiency, simplicity, and, once properly installed, is 'fail-safe'. When installing a 'drain-back' system, great care must be taken to ensure that pipes and headers are properly sloped or freeze damage can result. The nitrogen gas displacement method as originally employed at the Montevallo site is highly undesirable. It is expensive, requiring additional piping and N_2 compressors, complicated, and prone to failure.

3. Selective coatings (i.e. black chrome) significantly improve collector efficiency and are cost-effective in the Alabama climate.
4. Buffer tanks should be employed in solar cooling systems to 'decouple' the main storage, reducing thermal inertia and enabling the system to bring solar cooling on line quickly when cooling is required.
5. For winter heating and year-round domestic water heating, the optimum relationship of storage volume to collector surface area appears to be approximately 1.5 gal. per square ft. of surface area.
6. Care should be taken in selecting material for solar reflectors. Coefficients of thermal expansion should be checked when using laminating materials to prevent warping and delamination.
7. Commercial systems should include sufficient instrumentation so that proper system operation can be verified.
8. Simplicity of design will minimize maintenance problems and result in better system operation.

Appendix B

Section A5

RESIDENTIAL SOLAR THERMAL ACTIVITIES

Residential solar systems for thermal energy applications are available to supplement home space heating and water heating requirements. Such systems may be grouped as passive or active.

An active solar system requires equipment including collectors, duct dampers, piping, wiring and thermal storage areas. Currently, the most feasible active solar system appears to be water heating, which can be installed in both new and existing homes. However, because of the cost involved, each home must be considered on an individual basis.

A passive solar system works with the natural surroundings, using them to advantage wherever possible. It generally requires no moving parts, but it does require that a portion of a house have a southern exposure to the sun, with minimum obstruction from hills, trees or buildings.

Passive systems are best used when building a new home to help provide a portion of the heating needs. There are three types of passive systems, which can be used individually or in concert, depending on the type of home and personal preferences. All three should be carefully designed so they do not increase the summer air conditioning load:

- Direct Gain - Sunlight enters the living space through a south facing glass area, such as a large window. This system can often be used in existing homes.
- Trombe Wall - This passive system consists of a vertical masonry wall with a glass area in front. The sun ray's are absorbed by the wall, converted to heat, then transferred to the living space by conduction and radiation.
- Attached Greenhouse or Sunspace - An enclosed space with south facing vertical glass collects and stores heat from the sun. The heat is then transferred by convection (natural air movement) into the conditioned area of the home.

Changes in the angle of the sun from season to season must be taken into consideration when planning a passive solar system. Properly constructed overhangs are necessary to ensure that low-angle winter sun gets into the house, while high-angle summer sun is blocked to prevent the home from overheating.

A solar system cannot economically provide all home heating requirements during the worst weather conditions. Studies have shown, however, that it can provide a substantial portion of heating needs without contributing to the air conditioning load in the summer.

System companies have been involved in residential solar thermal demonstration projects for several years. While these installations have been experimental to some degree, the results generally indicate that solar energy can be successfully utilized to meet part of home space heating and water heating needs.

Demonstrations include a collector test-bed installation at Gulf Power and the construction and operation of houses with both passive and active features in Alabama and Georgia. The solar facilities were instrumented for the collection of load research data. Plan books of passive solar homes were developed and made available to System customers.

While this type of solar application is an appropriate technology for the home-owner, a cautious approach is advisable in the decision process. The system selected must be correctly engineered, installed and maintained in order to achieve good, long-term results.

Due to changing tax laws and readily available natural gas and electricity, customers have shown less interest recently in solar-equipment homes. System companies currently are not planning additional solar home activities. However, opportunities are available to use the Southern corporate infra-structure to market solar water heaters.

Appendix B

Section A6

INDUSTRIAL PROCESS HEAT

Georgia Power was an active participant in the DOE Modular Industrial Solar Retrofit (MISR) program in 1981 and 1982. This DOE sponsored program was administered by Sandia National Laboratories in Albuquerque, NM. The primary objective of the MISR Project was to develop a modular solar thermal line-focusing system offering near-term technical readiness, with proven reliability, and having a definite market potential for industrial process heat (IPH) applications. A modular system approach offered the potential of minimizing system costs by reducing one-of-a-kind engineering, reducing site specific construction costs, and simultaneously providing the solar equivalent to a packaged boiler for the present IPH market.

MISR systems were intended for retrofit installation for existing industrial process steam applications requiring saturated steam at rates up to 5220 lb/hr and at pressures up to 250 psig. The systems were intended to be comprehensive in that they included all of the solar collector equipment, heat transfer fluid circulation piping and equipment, electrical power distribution cabling and equipment, control and instrumentation cabling and equipment, steam generation equipment, as well as system documentation. Only site preparation, system assembly, and utility and process connections were necessary to make the systems operational.

Five companies were selected to prepare MISR system designs. These companies were selected based on proposals presented to Sandia National Laboratories. GPC worked with three of these five companies. Each firm designed 25,000 sq. ft. parabolic trough systems to supply steam at the conditions noted above. These three firms designed turnkey facilities for industries in Georgia. These designs were for a telephone cable plant, a chicken processing plant, and a plant for manufacturing polystyrene cups. However, none of these systems were sold due to the first cost compared to the relatively low operating costs of conventional systems. The efficiency of the systems was in the 50-60% range. At the present time further GPC involvement in solar systems design for IPH is on hold until the economics of these systems improve.

A conclusion drawn from the MISR program is that parabolic troughs for IPH systems have been developed to the point where no major technical problems remain. Economics do remain an obstacle but should begin to improve as the cost of fossil fuels increases. These factors suggest that an objective or goal for the System solar strategy might be to develop or have available a modular IPH system for the time when economics become favorable. Another goal would be to project the prices to which fossil fuels must rise to allow solar IPH systems to compete.

Appendix B

Section A7

SOLAR ENERGY TRAINING (SET) PROGRAM

Georgia Power is actively involved in national, regional, and local programs to help make solar technology reliable and economical. Among these efforts is the Solar Energy Training (SET) Program in which students have a unique opportunity to learn the state-of-the-art and earn college credits. They study first-hand the world's largest commercial and industrial applications of solar thermal energy—the Georgia Power Office Building, and the Solar Total Energy Project (STEP) at Shenandoah.

The SET Program is designed to provide participants with progressive and systematic training using the STEP. The six-month curriculum includes the following courses:

- Introduction and Application of Solar Technology
- STEP System Design
- Solar Collection Subsystem
- Power Conversion Subsystem
- Thermal Utilization Subsystem
- Control and Instrumentation Subsystem
- STEP Electrical Subsystem
- Electrical Supply Interface Subsystem
- Application/STEP Interface Subsystem

The nine courses, covering 26 weeks, require approximately 243 hours of classroom and field trip time (classes—156 hours; field trips—87 hours), with the remainder devoted to hands-on training and observation. A typical week involves three 2-hour classes.

At the conclusion of the SET Program, each student is asked to demonstrate proficiency before a Review Board consisting of the Manager of Solar Operations, a Georgia Power executive, a professor, a Georgia Power safety manager, and one or more representatives from outside organizations such as Sandia Laboratories of the U. S. Department of Energy.

To date, STEP has been the topic of several dissertations for advanced degrees from Auburn and Georgia Tech. One example is a Reliability Study done by Bill Schneider, a candidate for a Master's degree at Auburn. The study evaluated the reliability of the STEP system, and predicted performance using failure and repair data collected during operation. The effort required establishing a model of all subsystems and components, finding a means to measure cconfidence levels associated with failure and repair rates, and producing a fault tree analysis.

Considerable time was spent on analyzing the solar field because of the uniqueness of the model, which does not fit the traditional reliability model. (The field can be considered operational although less than the full complement of collectors is operational.) The result was a computer program that could be used for the STEP system as well as for the current Dish/Stirling project.

Results from the SET Program to date have been excellent. The program has provided an excellent means of training engineers on state of the art solar energy systems. Results of their work have been of direct benefit to the System. Plans call for continuing the SET Program.

Appendix B

System Solar Projects

Section B

Photovoltaic Projects

Following are summaries of the projects in which the Southern Company is involved with photovoltaic technologies. The System is currently involved in PV manufacturing, research and development with EPRI and various universities, remote installation of PV systems, and other projects.

Appendix B

Section B1

SOUTHERN INVESTMENT GROUP/CHRONAR
JOINT VENTURE

Through Southern Investment Group, Inc. (SIG) the System has entered into a joint venture with Chronar Corporation and AFG Industries. This joint venture is called Southern Chronar Photovoltaic Venture (SCPV). The project was envisioned by the System in order to develop the amorphous silicon photovoltaic cell economics to the point that it would be cost competitive with current energy supplied by U. S. based utilities. This project also was envisioned to identify the System as a progressive utility with long-range plans for supplying the energy needs of the Southeast region. Both of these goals are obtainable through the SCPV operation.

The SCPV joint venture was formed in November, 1985. This joint venture was designed to construct and operate a photovoltaic manufacturing facility in Birmingham, Alabama. This manufacturing facility will utilize Chronar Corporation's amorphous silicon deposition technology. Chronar Corporation will provide to the joint venture technical assistance and managerial personnel for the manufacturing process. The plant will produce 1 MW of photovoltaic material. This material, when installed, could supply approximately 250 average homes (Alabama territory) at the time of System peak.

The manufacturing facility will require approximately 25,000 sq. ft. of manufacturing space and approximately 5,000 sq. ft. of office space. This space is being provided by a renovated warehouse at the corner of 1st Avenue North and 13th Street, Birmingham, Alabama.

The manufacturing equipment and the technological license has a value of $7.2 million. The building and land are estimated to cost approximately $2.5 million when renovations are complete. SIG owns 85% of the manufacturing facility and 100% of the building utilized by the manufacturing facility. SCPV will lease its manufacturing space from SIG. The manufacturing operation will provide 60-90 new jobs for people in the Birmingham area.

Alabama Power Company represents SIG's interest through its participation in the SCPV Operating Committee. The members of this committee are as follows:

Alabama Power Company:	Randy S. Hardigree - Chairman Travis J. Bowden William O. Whitt
Chronar Corporation:	Zoltan J. Kiss
AFG Industries, Inc.	Rick Cunningham
Project Manager:	Herbert M. Boyd

The manufacturing facility includes the following basic equipment utilized in the amorphous silicon deposition process:

6 chemical vapor deposition furnaces
Metal deposition chamber
Lazers
Tin Oxide Deposition Equipment
Mechanical Scribers
Glass Cutters
Glass Washers
Aging Chambers
Encapsulation Equipment
Assembling Devices
Test Equipment
Packaging & Material Handling Devices

When this equipment is installed at the SCPV plant, the photovoltaic cells produced will have an average efficiency of 5%. The Formation Agreement calls for an increase in this solar conversion efficiency on an annual basis.

The general market area for the cells manufactured at the SCPV plan will be the continental U.S. and South America. Current plans are for Chronar to be responsible for the marketing of the products produced at the SCPV plant. However, it is anticipated that Southern Electric International (SEI) will aide in this marketing process. If cost reduction goals and efficiency goals are met, the future energy cost resulting from the installation of photovoltaic cells produced at the SCPV plant will be competitive with energy supplied to the end-use customer. The current contract with Chronar is for a period of ten years with renewable options every five years.

The manufacturing plant should begin operation by December 31, 1987. Request for bids on Phase II have been submitted. Approximately 11 contractors are scheduled to submit their bids on May 21, 1987. Based upon the outcome of this bid process, Phase II construction will begin within 1-2 weeks and actual construction is to be completed by October 31, 1987. Based on this schedule there are approximately five months of actual construction. No delays are currently foreseen in this project and the five month construction period should be adequate for the completion of the project.

The Joint Venture and Formation Agreements for SCPV provide SIG an option to purchase a flow-line manufacturing facility. This flow-line facility is currently being developed by Chronar. If successful the flow-line plant should provide lower cell cost and higher production capacities. At the present time there is no completion schedule for the flow-line manufacturing process. It is envisioned, however, that an economic evaluation of this process would be made by SIG when Chronar designates that the process has been developed.

Through SIG the system should continue to participate in the SCPV manufacturing facility and to monitor Chronar advancement of the flow-line plant process.

Appendix B

Section B2

EPRI PHOTOVOLTAIC PROJECTS

EPRI has developed a promising photovoltaic (PV) concentrator cell with Stanford University. Over a ten year period the cell efficiency has increased to better than 28%. Pre-production processing of the cell is being done at Acrian Corporation in San Jose, California. The prototype modules will be tested at the Shenandoah Solar Center.

So far about $8 million has been invested to develop the cell. It may require another $15 million to $20 million to demonstrate commercial viable mass production and to confirm full module performance at the megawatt scale needed for utility bulk power generation.

High-concentration PV systems that focus the sun's rays into intense beams on small-area cells and track the sun for maximum exposure are emerging as the frontrunner for meeting utility requirements for near-term economic bulk power generation. But because the technology is not applicable to such near-term markets as consumer products and remote power, private R&D investment has been low. With the aim of reducing the remaining technical and business risks so that private industry involvement can increase if warranted, EPRI sponsors concentrating-silicon-cell PV technology research that began nearly 10 years ago with scientists at Stanford University.

Thermal and optical testing of this prototype unit will be initiated at Shenandoah in June, 1987. Four utilities - Georgia Power, Pacific Gas & Electric (PG&E), Southern California Edison, and Arizona Public Service (APS) - are participating in the research and commercialization of this viable photovoltaic option. Collectively they have committed $4 million.

EPRI is also supporting photovoltaic field testing at GPC, PG&E, and APS. The Southern Company installation will initially test both flat plate and concentrator cells. These include modules from Arco, Solarex, Chronar, Westinghouse, Intersol, and EPRI. Other state of the art modules will be tested as they become available. Most of the electrical testing data will involve current voltage characteristic curves. Curves will be produced periodically throughout each day on several modules from each supplier. Among the data measurements will be current, voltage, module temperature, ambient temperature, wind speed, and irradiance measurements.

There are three major areas of use for photovoltaics. One is consumer products which use lower efficiency cells, such as Chronar. Applications include calculators, walk lights, auto or boat battery chargers, and many more. Secondly, there are remote applications for irrigation pumping, residences, airport lighting, and so on. Thirdly, there are utility scale applications for the most efficient systems.

Projects for future cost range from $1 to $3 per watt installed. To build a module manufacturing facility for the EPRI point contact cell would be a two year undertaking. Utilizing state-of-the-art equipment such as robotics and larger size wafers would require an investment of $40-60 million. Other options with less automation could be done for less finances in a shorter time. The Southern System is monitoring relative low cost-low efficiency and high cost-high efficiency choices which will make future decisions on business ventures and PV use more profitable.

Appendix B

Section B3

PV/ELECTRIC UTILITY/RESIDENTIAL INTERFACE

In the past, electric utilities were completely in control of power production and delivery, from the generator to the customer. Except for a few interconnected industrial and large commercial cogenerators, no other small power producers fed power into the utility grid. However, PURPA Section 210 - Cogeneration Rules established the opportunity for smaller, dispersed power producers to sell power directly to the utility.

Concerns were soon expressed by the utility industry over power quality, system security and personnel safety. The possibility of large numbers of residential-sized (2-4 kW), roof-top photovoltaic systems tied into the grid led to uncertainty and reluctance on the part of the utility to willingly interconnect these small systems of unknown performance. The potential for larger systems increased the concern.

In order to support utility investigation and resolution of interconnection issues, Sandia National Laboratories funded a series of contracted research projects which followed basically the original research agenda established under the Photovoltaic Southeast Regional Experiment Station (PV SERES) Utility Research Group (URG), which the Southern system helped establish. Please see Appendix B, Section C3 for URG details.

The Sandia contracts included the following projects performed in conjunction with the URG:

- "Methods for the Analysis of the Impact of Harmonics from PV Power Conditioners on the Utility Grid"
- "Utility Research into Utility Interactive Photovoltaic Systems"
- "Investigation of Potential Islanding of Dispersed Photovoltaic Systems"
- "Development of a Photovoltaic Voltage Impacts Investigation Technique"

A brief description of the preceding projects follows.

1. Methods for the Analysis of the Impact of Harmonics from PV Power Conditioners on the Utility Grid

The project objectives included:

- Characterizing the levels of background harmonic distortion on two utility feeders.
- Investigation of the propagation of PV-injected harmonics along utility distribution lines.
- Development of a computer model to evaluate the impact of large PV penetrations on distribution system harmonics distortion levels.

The field sites were Roswell, Georgia (Future 1) and Huntsville, Alabama (Alabama Solar Energy Center). The project was coordinated by Georgia Tech, with participation by the URG utilities, Sandia, the Alabama Solar Energy Center, and the Florida Solar Energy Center. Primary support was provided by GPC, SCS, and APC in the way of field test personnel and equipment, computer simulations, and related expertise. SCS used the Electromagnetic Transients Program (EMTP) to simulate varying levels of PV penetration.

The basic problem was to determine the contribution by photovoltaic systems to harmonics already on the distribution feeder. The conclusion was that the extremely site-specific nature of utility distribution feeders made it impractical to develop a rule-of-thumb or guideline concerning the level of PV penetration that can be applied to all feeders. Therefore, depending on feeder characteristics and loads, PV systems may or may not be a problem. Twenty percent penetration would not be a problem with high quality DC/AC static power converters. However, not all converters produce clean sine waves. This suggests continued monitoring of commercially available converters intended for grid-connected applications.

2. Utility Research into Utility Interactive Photovoltaic Systems

The project tasks concerned the following objectives:

- Static power converter testing for output harmonics, run-on during isolated operation, response to faults, and other tests.
- Islanding experiments planning and execution.
- Impact analysis of photovoltaic systems on utility transmission and distribution system.
- System operation, system planning, and generation planning impact analysis.

A proposal was submitted to Sandia RFQ 47-4279 through SEI on September 30, 1983. A contract was awarded to SEI with Georgia Power serving as project manager and SCS providing project support. A test procedure was devised for static power conditioner experiments to be carried out at the GPC Wabash Substation. The results showed that sustained islands could occur. (An island is defined as continued converter operation immediately following a utility feeder outage.) During field tests by GPC at the Florida Solar Energy Center, under certain combinations of loads, sustained islands were created.

The balance of the work involved SCS analysis and perspective on significant interconnection issues. Topical areas included reactive power requirements, transformer tap changes, relay operation, harmonic injection, generation dispatch, automatic generation control, spinning reserves, unit commitment, and others. A copy of the report is available for details.

3. Investigation of Potential Islanding of Dispersed Photovoltaic Systems

A proposal was submitted through SEI on May 9, 1985 to Sandia RFQ 59-3704, with Georgia Power taking the responsibility for (1) program management, (2) lab testing, and (3) field experiments. Southern Company Services accepted responsibility for (1) modeling and experimental design and (2) final analysis and reporting. Individual tasks and objectives were developed for each of the five areas of responsibility.

As defined before, an island is a condition in which the DC/AC static power converter (SPC) of an interconnected dispersed generator continues to energize the grid immediately following the loss of the utility grid. A sustained island could jeopardize utility line crews repairing a distribution feeder. To address the islanding issues, the following general plan was utilized for this project.

- Develop analytical models of all elements of a generic PV system including static power converter and distribution systems.
- Predict boundary conditions for SPC islanding.
- Experimentally validate analytical models.
- Suggest factors to alleviate isolated operation.

The analytical work predicted that, for the specific SPC's under consideration, the line-commutated SPC would run-on indefinitely (under many load conditions) and that the self-commutated SPC would detect the island condition and shut down operation. The field tests performed at TVA facilities in Chattanooga with these specific SPC's verified the predictions. The lab tests also confirmed the analyis. The islanding problem with the line-commutated SPC should be minimized with a frequency relay that would take the PC out of service on a boundary condition of ±1/2 Hz.

The project is basically complete, with final reporting planned for the third quarter of 1987.

4. Development of a Photovoltaic Voltage Impacts Investigation Technique

The Sandia RFQ 01-0455 was responded to on August 29, 1986 through an SEI proposal by Georgia Power, Alabama Power, and Southern Company Services. Responsibilities are as follows: GPC - program management; APC - program monitoring and technical reviews; SCS - modeling, demonstration problems, final analysis and reporting; and Dr. Sheldon M. Jeter (Georgia Tech) - develop necessary solar radiation and cloud model.

This project differs from the previously described Sandia projects in that no experimental work (lab or field) is required. The work involves simulation only. The objective is to study the impact of PV on the voltage of a utility distribution network, using meteorological and solar radiation data. The work will proceed as follows:

- Develop a computer model to predict voltage fluctuations on a utility distribution feeder due to PV.
- Develop a computer model of cloud patterns.
- Simulate several typical distribution systems with PV generation, using the above models, while varying a number of parameters individually.
- Provide a comprehensive, publishable report of the entire project.

The projected completion date is October, 1987.

Appendix B

Section B4

RESIDENTIAL AND STAND-ALONE PHOTOVOLTAIC PROJECTS

There have been many successful applications of photovoltaics in residential applications when they were in remote locations. Otherwise the cost of owning and operating PV exceeds the cost of conventional purchased power by a factor of 5 to 10 times. There are thousands of cost effective stand-alone applications. Most of these utilize photovoltaic modules for lighting, irrigation, line switching, highway monitoring equipment, and the like.

Georgia Power Company Solar Operations (through Southern Electric International) is conducting a Sandia National Laboratories sponsored program that investigates the impacts of photovoltaic power generation which feed the electric grid. The impact of these systems on utility equipment is unknown. Questions concerning islanding and voltage regulation are being addressed. The program includes development of a model to accurately predict the effects of operation of dispersed PV systems and incorporation of this model into an existing utility flow program. Cloud modeling analyzes the effect of cloud movement through the service area. When the time comes for PV penetration into the general residential marketplace, information developed in programs like this will be most beneficial.

A couple of years ago, GPC was directed by the local law enforcement to place lighting at a boat dock and ramp area on our Lake Juliette for safety and security reasons. Because of its remote location, it would have cost over $30 thousand to provide conventional power to the small electric load. A photovoltaic system was installed for about $3,000. It performed so well that a second system has been added at a nearby location. This solar application has been repeated many times including four units that are at Carters Dam and four units at West Point Lake.

The System uses photovoltaic systems to switch power on transmission lines and for aircraft lighting on these lines. As a demonstration, PV powers a water cooler on one of the golf courses at Callaway Gardens. It is used in remote application at Plant Farley near Dothan. At Shenandoah PV is used for outside lighting to power fans and to serve a meteorological station.

Several GPC people within the Marketing Organization successfully managed the construction and testing of one of the nation's first privately financed solar research homes. After 16 months of public display and demonstration at the home called Future I in Roswell, the house was occupied by a family for additional testing in an actual "lived-in" situation. Included in the comprehensive final report were these facts concerning the performance of the PV system:

(1) The 4.2 kW PV system produced 4790 kWh of electricity during the one year the house was occupied.

(2) Although the total PV output was equal to 22% of the total house electrical consumption, it actually displaced only 17% of the house load because of the problem of load matching.

(3) The quality of the 1170 kWh, provided to the GPC electric grid, was high.

(4) The power conditioner, which converts DC to AC, operated flawlessly.

(5) These early generation PV modules exhibited efficiencies from 10 to 12% as a function of ambient temperature.

To further the benefits from the initial investment, the photovoltaic array has been relocated to Shenandoah. It now is being tested on a two-axis tracker to determine the relative energy produced by fixed, one axistracking, or two axis tracking.

The choice for tracking as well as flat plate or concentrator are being made in experiments like "Future I". Answers are continuing for using photovoltaics in residential applications or by a utility for peaking power.

Although grid connected residential applications are in the future, the stand-alone PV applications are here today. With the cost of producing phtovoltaic modules going down every day, it will not be too long before the grid connected residences may have PV providing a significant electrical output. For instance, Solarex and Philadelphia Electric believe they can mount PV like shingles on rooftops and make significanit penetration into the marketplace with 5 kW installations.

Appendix B
Section B5

UNIVERSITY PV RESEARCH

As mentioned in Section B.3, an extensive project was conducted by Sandia (SND84-7008) to investigate the impact of dispersed PV systems on the voltage profile of utility distribution lines. This program, performed at the University of Texas at Arlington (UTA), looked at two actual residential feeders in the Texas Electric Serviice Company system. The time dependent impact of up to 30% PV penetration was closely correlated with an existing PV home on the campus, and no apparent problems were found.

In a current program for Development of a Photovoltaic Voltage Impacts Investigation Technique, also sponsored by Sandia, the Georgia Institute of Technology (Dr. S. M. Jeter) is responsible for developing the radiation and cloud model needed to complete the work, and is assisting in meeting the overall objective: development of a model to accurately predict the effects of operation of dispersed PV systems and incorporate this model into an existing utility load flow program.

The Alabama Solar Energy Center at the University of Alabama-Huntsville (UAH) is presently involved in a two-fold study for APC.

One project is to determine the performance and degradation of Chronar amorphous silicon PV modules over an extended period of time. Modules have been under study for approximately 300 days. Results indicate a substantial initial degradation which has recently leveled out at efficiency levels between approximately 1.3% to 2.6%.

The second project involves developing a model to study the behavior of modules when combined into arrays. The model includes a computer program which allows the manipulation of 3 parameters: quality factor, series resistance, and shunt resistance. Experimental testing of the model is presently underway.

Appendix B

System Solar Projects

Section C

System Coordinating Projects and Industry Affiliations

Following are summaries of industry and System solar projects for which System personnel provide coordination. Also included is a list of industry committee memberships and contacts with which System personnel are involved.

Appendix B

Section C1

EPRI RENEWABLE ENERGY TASK FORCE

The EPRI Renewable Energy Task Force is in the Advanced Power System Division of the EPRI organizational structure. The Renewable Resource System department has basically three programmed areas. These areas are photovoltaics, wind/power electronics, and technical assessments. The renewable resource task force directs its efforts toward research activities in these programmed areas.

The goal of System participation in the EPRI advisory group is to direct the EPRI research effort toward projects which will provide future benefits to the System.

The Solar Power Systems program has established for the 1987-89 planning horizon the following major program thrusts:

PHOTOVOLTAICS

- Point Contact Photovoltaic (PCPV) Cell Development (1986-1988)
- High Concentration Module Development (1986-1989)
- High Concentration System Tests (1987-1989)
  - 20 KW arrays; 30 kW systems initiation
- Amorphous silicon thin film R & D (1986-1989)
  - Materials science basic research emphasis

- Field Test Evaluation
  - Utility-Scale emphasis

WIND/POWER ELECTRONICS

- Field performance and reliability evaluation (1986-1989)
- Participation in industrial develop program(s) for advanced wind turbines (WTs)
  - System-integrated power electronics
- Power electronics requirements for other renewable technologies

TECHNICAL ASSESSMENTS

- Solar thermal SOA perspective (1986-1989)
- Other Evaluations on opportunity basis

The Solar Power System Program budget for the 1987-89 planning horizon is projected as follows:

SOLAR POWER SYSTEMS PROGRAM

1987-1989 PLANNING HORIZON BUDGET

($000)

	1986	1987(2)	1988	1989
Photovoltaics(1)	5,300	5,100	4,500	4,700
Wind/Power Electronics	700	500	500	500
Technical Assessments	200	300	200	200
Total Program	6,200	5,900	5,200	5,400
Exploratory Research	270	400	400	400

(1) Supplemental sponsors' funding for PCPV not included

(2) Includes 1987 program augmentation

The Renewable Resource Task Force continues to support a photovoltaic field testing program and has approved additional funds for several reports during 1987 and 1988. These reports will document the photovoltaic array performance with approximately five sites.

The Renewable Resource Task Force program in the power electronics area is designed to coordinate EPRI's power electronic research. The task force has established power electronics as one of the areas where improvement in equipment and technology will benefit all of the solar technologies.

The Renewable Resource Task Force is committed to the EPRI R & D Program Strategy of:

- Increased emphasis on seeking and developing breakthroughs that could significantly reduce the cost of producing and delivering electricity for member utilities.
- Recognition of EPRI's important role in catalyzing development of technology that will help utility customers compete more effectively in their markets, and
- Allocation of up to 10 percent of the EPRI program to exploratory research.

Mr. H. M. Boyd of Alabama Power Company is the System representative on this task force.

Appendix B

Section C2

SOUTHERN COMPANY RESOURCE EXPERIMENT COORDINATION

This project was initiated in 1987 by Southern Company Services (SCS). Its objective is to identify and quantify the solar energy resources available within the System territory. The project consists of the development and installation of a prototype monitoring station. This prototype monitoring station will measure radiation intensity, temperature, relative humidity, barometric pressure and wind speed. The solar radiation (insolation data) will be recorded in several configurations including horizontal global, global with a fixed tilt, direct beam and global tracking. These measurements will be taken at regular and frequent intervals and permanently stored, processed, and analyzed.

The cost for facilities similar to the one being installed at SCS is approximately $48,000. Should the System expand this program, it is planned that future monitoring stations would be paid for by the operating company in whose territory the monitoring station is installed. The data which can be derived from these monitoring stations will assist in the economic evaluation of future photovoltaics systems and solar thermal stations within the System territory. It is envisioned that thi project would continue to take solar radiation measurements for at least a period of five years and much longer, if necessary. The project manager at SCS is Mr. J. T. Petty.

Appendix B

Section C3

PHOTOVOLTAIC SOUTHEAST REGIONAL EXPERIMENT STATION

UTILITY RESEARCH GROUP

The Photovoltaic Southeast Regional Experiment Station (PV SERES) represents a long-term effort to evaluate applications of photovoltaic energy systems as small, electric-utility-connected power sources. The Florida Solar Energy Center (FSEC) at Cape Canaveral is thee prime contractor with the U. S. Department of Energy for performing this work, while Georgia Tech served as a secondary contractor for the first few years.

At the FSEC site, three small buildings were constructed to provide residential-type roof area for mounting photovoltaic test arrays. These test arrays have been closely monitored over the years to provide long-term performance data. The results indicate that residential photovoltaic arrays are reliable producers. Problems were encountered with some DC/AC inverters initially, but newer inverters are more advanced designs and seem more dependable.

At the time the proposal to DOE for the SERES was being prepared, a decision was made to create a special task force, called the Utility Research Group (URG), to investigate utility-related isues. Georgia Power and Southern Company Services worked with FSEC and Georgia Tech to write the winning proposal. Membership in the URG currently includes the following organizations:

Alabama Power Company
Georgia Power Company
Southern Company Services
Tennessee Valley Authority
Virginia Power

Florida Power & Light
Florida Solar Energy Center
Alabama Solar Energy Center
North Carolina Alternate Energy Corp.
Sandia National Laboratories
Other Interested Parties

In the U. S. electric utility industry, the URG is unique in that the efforts of the member utilities are geared to the successful integration of photovoltaic systems into the electric utility power grid. Toward that goal, a research agenda for utilities was established, as part of the proposal to DOE, to identify, investigate, and resolve photovoltaic interconnection issues. Included on this agenda were harmonics injection, islanding (continued PV operation or run-on immediately after grid outage), grid voltage regulation and other topics. Through SEI contracts, Georgia Power and Southern Company Services were successful in obtaining funding from Sandia National Laboratories to investigate islanding and voltage regulation. This is described in more detail in Section B3, Appendix B, "PV/Electric Utility/Residential Interface". The PV SERES contract at FSEC has been renewed each year despite a declining DOE solar budget. Whether future funds will be available is uncertain.

The URG is in the process of changing leadership and redefining its long-range goals. The URG was chaired during its first three years by Georgia Power and its second three years by Southern Company Services. New leaders from other utilities were recently installed. A revised five-year research plan will be developed by November, 1987, with emphasis on utility member participation in a continuing program to identify remaining photovoltaic/utility issues. The opportunities for the System in the URG are to exchange operating and performance data for PV systems, resolve remaining interconnection issues, present a strong, unified voice to EPRI on Southeast utility PV concerns, and to generally assure future options for PV generation. The URG supports Solar Strategy Objectives 2 and 3.

Appendix B

Section C4

OTHER COORDINATING PROJECTS AND AFFILIATIONS

Georgia Power has for several years held memberships in the Solar Energy Industries Association (SEIA), the American Solar Energy Society, and the International Solar Energy Society. These associations are relatively inactive because of low fuel costs and no U.S. tax credits. Healthier associations and organizations, such as IEEE, ASHRAE, and the national labs, however, are lending their efforts to maintaining the solar voice that an SEIA represents. Mr. E. J. Ney of GPC has represented the System with these organizations.

The Shenandoah Solar Center has maintained a dialogue and minor association with numerous international groups. One such group is the International Energy Agency (IEA), which has members from Germany, Spain, Switzerland, Sweden, Italy, France and other European countries as well as the U.S. (DOE and Sandia National Labs). A working group discusses and then implements projects of mutual interest. Two joint projects were power generation using a central receiver and power generation using parabolic troughs (in Almeria, Spain). Mr. E. J. Ney of GPC has been the System contact with IEA.

Among the American Society of Heating, Refrigeration, and Air-Conditioning Engineers (ASHRAE) committees in which System personnel participate is the Solar Energy Utilization Technical Committee (TC 6.7). This committee addresses solar related questions concerning the society. The major areas of interest are Handbook sections relative to Solar Standards, programs for Winter and Summer Meeting (January and June), and Research. Mr. J. W. King of GPC serves on this ASHRAE committee.

Other industry organizations in which the System participates include the following:

- Alabama Solar Energy Center
  W. C. Martin, Jr., (APC) Member, Board of Directors
- Florida Solar Energy Center
  J. T. Petty (SCS), Member, Policy Advisory Board
- Solar Energy Research Institute
  J. P. McCloy (GPC), Member of Advisory Board

Senator FOWLER. Thank you, Mr. Ellingson, very much. Mr. Grundy wants to ask you something.

Mr. GRUNDY. Since you are with an electric utility, there is one generic question that I think I would like to ask you and that deals with what can be done by public service commissions and electric utilities to overcome many state commissions' concerns that new technologies do not represent prudent investments. It is alleged that regulatory barriers are important to the introduction of these new technologies as are the R&D barriers. Could you comment on that?

Mr. ELLINGSON. Well we have not had a problem getting our research and development funds approved in our rate cases during the last ten years, and we have spent quite a bit down at Shenandoah. There are some risks involved starting off on a technology path and public service commissions are beginning to understand a number of the risks now, and at least in Georgia there is enough of a forum with the regulatory agencies here to talk about possibilities and potentials. When we find a technique that we think we can use, we do go to the Public Service Commission and talk to them about it and if it is going to require substantial investment, we will have discussions about those things.

Now generally in the United States I think there is a fear on many utilities' part that if they did invest in techniques and it did turn out to be profitable, there would be no profits to gain. And because of that——

Senator FOWLER. Why? I do not follow that.

Mr. ELLINGSON. Well when oil prices run up, if it is an accident or some political event, at least in the past private industry has experienced price controls or attempts to direct resources into other activities. There is not anything wrong with that because there are people that can be injured, but when that happens, firms are not willing to take risks because there are no rewards available to take the risks.

As long as we have one set of policies that say we are not going to let anyone get injured, it also means that you are not going to let anyone get any gains and so no one is going to direct their efforts into high risk opportunities, and that is one of the things that is preventing private industry from investing as heavily and other high-risk technological areas.

Senator FOWLER. When you suggest that we concentrate what Federal resources that we will have or will appropriate on research and development, do you include in that what us laymen call commercialization; for instance, on photovoltaics as an example? Are you concerned about the federal government of Japan and the private sector in Japan in their work on photovoltaics and how that market seems to have gone away from the United States and over to the Japanese?

Mr. ELLINGSON. Basically the Japanese commercialization has been in small modules, photovoltaics used in clocks, calculators, games, other very small——

Senator FOWLER. So far.

Mr. ELLINGSON. So far. Again, what we can gather, they are doing a lot of work in amorphous techniques and we think that is a promising area as well. Right now I think we have a lead on large-module development in the United States of amorphous techniques themselves. I know the manufacturers tell me that the Japanese are always asking to see their production processes. They are much less open now than they were ten years ago. Ten years ago anyone was welcome in the laboratories and test areas. Now everyone in the United States is welcome, the Japanese are not. And that is basically the way they are operating. I think the Japanese have not reached large scale, large module development.

Senator FOWLER. Do you separate that kind of funding for commercialization and commercial application of these kinds of techniques away from R&D?

Mr. ELLINGSON. Yes. Commercialization can occur, and I think once techniques are discovered, private firms will go ahead and commercialize. But it is the development of the techniques themselves that is risky and that people are reluctant to pursue individually, and that is where the government should concentrate.

Senator FOWLER. Well when do you get involved—let us say fossil fuels became unreasonably high or outrageously high during the next ten years in this country. What sort of role would you see the Georgia Power Company playing in the design, installation, maintenance of solar water heaters, for instance?

Mr. ELLINGSON. We would look at solar water heaters. Although they do displace fossil fuels, given their load pattern, water heater load patterns in Georgia versus our system load, we—it would not affect our oil consumption very much at all to have solar water heaters in our system. It would affect our consumption of coal, which is relatively low-priced. And in that sense it would not be as beneficial as say desiccant dryers at the time of our peak, or photovoltaics or Stirling heat engines. Even though I am talking about very large devices, there are a number of Stirling engines that have been looked at that are only 7 KW to 10 KW worth of power, a household very nicely. So they are modular and they can be disbursed or they can be concentrated in large fields. The economics of one over the other depends on maintenance and other costs besides just the cost of the machine.

But we would be prepared to look at those kinds of things during oil price run-ups, which is why we have been studying for so long. We do have generation expansion decisions to make in the mid nineties and the early 2000's. Right now our plans call for gas fired and oil fired combustion turbines. This is the area where we think solar has the most application in replacing those kinds of additions. And there are some breakthroughs that could occur with proper funding between now and 1990 which would leave three to five years for scale up and commercialization.

Senator FOWLER. Well, Mr. Ellingson, we could go on, but if I am going to keep my commitments to everybody else, I guess we had better call time. Thank you, and I assume you are not going anywhere. Thank you so much for your testimony.

Mr. Daniel J. O'Neil, Associate Director of the Energy and Material Sciences Laboratory at Georgia Tech.

It is a pleasure to have you, Dr. O'Neil, and as you know your full statement will be made a part of the record. Thank you for taking the time to be with us. Proceed as you would like.

STATEMENT OF DR. DANIEL J. O'NEIL, ASSOCIATE DIRECTOR, ENERGY AND MATERIALS SCIENCES LABORATORY, GEORGIA TECH RESEARCH INSTITUTE, GEORGIA INSTITUTE OF TECHNOLOGY

Dr. O'Neil. Thank you, Senator Fowler, Vice Chairman of this Committee, to your staff and to your colleagues in Washington for the opportunity to present some of the views at least of the Georgia Institute of Technology and some of our own experiences, which span well over a decade; in fact, two decades in the broad area of solar energy and conservation. I can only hope in the limited time available to me to touch certain of the key points and I am sure Frances Zwenig will be pleased with that. If I had to read this I would have to compete I think with Robert Preston, who is no longer with us as a matter of fact.

So let me begin by saying this, that our institution is unabashedly protagonistic toward your Committee's endeavors and your personal endeavors in behalf of implementing an energy policy which will meet the requirements of this century. We pretty firmly believe, as do others, that another oil crisis will be upon us probably—I would say by the end of your second term in office and no later than——

Senator Fowler. You can take as much time as you would like. [Laughter.]

Dr. O'Neil. With that, I would like to repeat or highlight some of the points that were reached in the Conoco report, which does indicate that in 1983, we were importing only 4.3 million barrels a day. That prediction grows, evolves to 11 million by the turn of the century, the year 2000. And when we think of that, we think pretty futuristically but it is only 13 years.

The dependence then grows to 60 percent. We know we are struck with catastrophic employment situation, production situation along our Gulf coast with wells closing down, no new wells being opened. What we see in response to that is what I consider to be an abysmal record in the energy area, as if this is not a crisis within our country.

This year's fiscal 1988 budget for the Department of Energy is $13.9 billion, that is the administration's request as you well know. Of that $8 billion addresses defense addresses defense related matters. Looking at it another way, only $2.9 billion of that addresses energy R&D.

Now that masks a lot of things. In other words, many things which are deleterious I think to our future progress in the energy area; namely $2.9 billion being for energy R&D. Of that only $94 million—I heard a $70 million figure earlier, we will not debate that—is being addressed to solar issues.

Now to put that into perspective, my institution, Georgia Institute of Technology, had contract research and development expenditures last year of $105 million. So essentially we are putting in less than what our budget is, on a national basis for solar and renewables, and we consider that entirely inappropriate.

We could go on with these statistics and that would include conservation, which is being cut in half from a proposed $160 million approximately to $80 million. These messages are clear to those in the energy community. Unfortunately they are not front page material any longer. What we are highlighting I think is the fact that we are headed in that direction and the day of gas lines will be here, if not in five or ten years, certainly we think within a two decade period.

Senator, I would like to discuss a few of the major areas of research which we undertake at Georgia Tech. You talked a little bit about commercialization, so I would like to preface this by pointing out that as one of the largest research universities in the country, we are proud of the fact that approximately 25 percent of our R&D is done for industry, on behalf of them. That is about four or five times the national average. And among public universities in this country, it places us number one.

The point is, we are not trying to isolate R&D or the laboratory from the larger economy in the industry. We feel that is a vital part and many of our projects are of a cooperative nature where we are trying to bring together the force of industry, their intellect and their financial power, with that of the government, conceding many of the high-risk R&D long range types of energy initiatives.

My safest bet now is to refer to my executive summary and recommendations rather than going through the other seven or eight pages.

Senator Fowler. I do appreciate the comprehensiveness of your testimony and the detail on the work at Georgia Tech in everything from advanced solar manufacturing of strategic materials to energy conservation. It will be very informative to my colleagues and very helpful when we get to the debate on the final budget figures.

Dr. O'Neil. Well, we appreciate the fact that your task is pretty difficult and there is a minor degree of self-interest probably in some of those initiatives or declaration.

Senator Fowler. As long as it is not major. [Laughter.]

Dr. O'Neil. Solar thermal technology research was alluded to by the previous speaker. We feel that is a major problem and one which must be kept together within the context of the Department of Energy's budget. We feel that with maintaining a level equivalent to about fiscal 1985–86 dollars, preferably something in the $30 to $40 million a year range, that solar thermal technology can meet its goals, which have been very comprehensively defined in a five-year multi-year plan by the program managers at DOE. We think this is one of the really good groups on the ground, frankly, in Washington. With that, by the mid-1990's—and using 1986 dollars—electricity could be generated from central power systems such as Solar 1, that being a model, at five cents a kilowatt hour. Right now, Senator, those numbers look like 15 cents a kilowatt hour. What we are doing is creeping up on some real valid targets, but underpinning that is a requirement for some fairly substantial R&D.

I am going to digress just one second. We—I showed in my written testimony a graph of the decline of the—the buildup and the decline of R&D dollars in this country over the last decade, peaking about 1980. We do not think necessarily at this stage that it calls for the peak values, the $100 millions, $150 millions a year that were being spent. We have become more efficient I think in expenditures of R&D, but we do feel that there is a minimal level below which you cannot go and have an effective national program.

We think solar thermal has demonstrated time and time again its ability to reduce costs. What is really important here is it is a developing industry. These are small companies, 40 percent of them have gone by the wayside. And yet with the limited financial resources that that solar thermal industry had, they were able to come up with approximately 30 cents for every Federal dollar that was expended in R&D. And the Solar Industry Association, with which we are fairly familiar, has indicated that maintenance of the $30 to $40 million a year budget will allow them enough financial or cash flow to match on a one-to-one basis, a dollar-for-dollar basis. So we think that is an important feature, five cents a kilowatt hour with a reduction by the mid-1990's to something in the order of $9 per million BTU of processed heat.

If we need to look at achievements there, the value of—the cost of a heliostat for instance in 1976 was about a thousand dollars per square meter. That was reduced by Arco a couple of years ago to $120. And membrane heliostats which are in a research and development mode at Sandia by SAIC and other people, Solar Energy Research Institute, have a projected cost by 1988 of $60 to $80. And that is real achievement.

I am afraid with the budget as planned, something in the order of $15 million this year, we will not have a program which is something very sad.

We are at the heart of it, we have the advanced components test facility which is about a $2.5 million facility which we have run since 1977 across from campus. It is sized right, it can handle a lot of components, we have worked for 30 or 40 different companies, with Department of Energy and everyone else. That is essentially in a mothball state because we were given an opportunity to say what will you do with the limited amount of R&D dollars. The business was not there, so we really have something which is a valuable asset that is——

Senator FOWLER. Not being used.

Dr. O'NEIL [continuing]. Being greased in oil. Unfortunately the budget as proposed this year, will virtually convert that into a rusting condition.

We think these are manifestations of what this continued budget slashing has done. It has gone beyond prudence. It has gone to the point where we are destroying ourselves.

Senator FOWLER. Let me ask you this, Dr. O'Neil, if we could assume sufficient funding or even level funding, some sort of constancy I guess is the word I am looking for, to the funding over a five or six or eight year period, what predictions would you have as to the probability of getting university, industry and government to work together as a consortium on solar thermal advanced technology, joint ventures, joint cooperation where we could show everybody that we are getting the bang for our citizen buck.

Dr. O'NEIL. There is a very high probability of success with that approach. I can say this very sincerely having just—what we have done in order to maintain survivability at Georgia Tech, is to go and look where we can get additional solar funding beyond the Department of Energy, and we turned to NASA. NASA has a program out of its Office of Commercial Programs, unfortunately which terminates this year, for funding non-profit based university center consortia for various specific space commercialization enterprises.

As you see up here over my right hand shoulder, the model of the space station clearly demonstrates that solar photovoltaics and solar thermal, the latter being the primary choice of Apollo system for lunar and for space stations, is the way to go. We have just recently mobilized a consortium and have proposed that in Washington, waiting hopefully with bated breath for a positive decision on that.

The point is——

Senator FOWLER. Is that at NASA or is that DOE?

Dr. O'NEIL. That is NASA. DOE has supported this. What we are trying to do is mobilize what is left of the solar thermal community terrestrially and bring it to bear in our national space enterprise with the Department of Energy's assistance. And something in the order of 12 organizations have joined us in that proposal, six or seven of those are major industries and it includes the Solar Energy Industry Association.

That is a long-winded answer to give you a positive answer in anticipation of what might happen with the kinds of initiatives we are talking about.

Solar photovoltaics was spoken to. We do, as Georgia Power alluded to that, have a major program on campus and we believe pretty much that the work that is going on at Tech and elsewhere has got to be maintained if we are to recoup the lost markets that we have worldwide. Only four years ago, the United States commanded 80 percent of the world market in photovoltaics, it is less than 50 percent now, and that is the trend.

Senator FOWLER. And going down.

Dr. O'NEIL. Yes, sir. There are requirements of a basic R&D nature to lift the efficiencies of the solar cells up to 15 percent and beyond. Interestingly, if you take one of the discoveries essentially of the solar thermal program, use of concentration energy, and marry that up with photovoltaic energy, there are claims that 26 to 28 percent efficiencies are possible.

The benchmark by the way, solar thermal efficiencies, the world record as it were, is 31 percent, and that is with a solar thermal United Stirling—I am sorry, U.S. Stirling engine. So we are working in the right area with both areas.

And I firmly believe that what is good for solar thermal is good for photovoltaics. I hate to see the competitiveness and the maneuvering for place going on at this stage in the development of any of these technologies. These all have to be nurtured along. I do not know which son or daughter is going to become a Senator or President, but I know that unless they get the same fertile ground and the same advantages, neither one of them are likely to achieve something like that.

The other major area of technology which is close to the heart of Georgia Tech and close to the heart of this state and this region is biomass. That, Senator, suffers from annual chaos in that there have been turnovers of personnel, there is no national policy—there is no plan that has any rhyme or reason or continuity, unlike the solar thermal five year plan that has been put together. It vacillates in the budget slash. It is an open field day for anybody that wants to go after a budget. We would like to see that protected, elevated back up to where it belongs.

Three percent of our national primary energy demand is already being met by biomass, principally through combustion with our forest products industry, but also alcohol fuels from biomass making in-roads and helping us. I noted that Denver, Colorado the other day is requiring gasohol to be used with their gasoline in order to reduce their brown smog during the winter months. It has made the oil companies slightly unhappy but it is a realistic approach to handling an environmental problem as much as it is an energy solution.

There are other ways of going at this, but we think the advanced technologies are required. That is, the liquification or the liquefaction of fuels. We have got a process on our own campus which we have nurtured for the past few years and are hanging on by our fingernails in this technology area, which from an independent study looks—that is not Georgia Tech's own figures, that is to say—indicate that we can produce a barrel of crude oil equivalent from wood liquid fuels at $18. So we are not very far off from where the national or the international market is already for crude oil. If this were seven or eight years ago, we would have our doors being pummelled by everybody in creation. Most of our inquiries these days frankly come from overseas, Scandinavia and France who is looking at a Francophile market for renewable energy resources. We think that is a vital one to keep alive.

The second major program which we have is an integrated approach to using our wood resources. Somebody mentioned this and I think John Mixon will talk about some of the potential, but at least ten years ago when I worked on this with the Georgia Forestry Commission, we predicted something like 50 percent—15 percent of the energy needs of the State of Georgia could be met from wood alone. Wood waste, we are not talking about taking every tree in Georgia down by any means. At that time——

Senator FOWLER. Wood chips from the waste?

Dr. O'NEIL. Wood chips, wood residues, trees which are cull timber, the hardwood forests which only have a limited application for furniture. So we are not—we do not choose, nor does it make any economic sense to take your best timber and use that for energy needs, not in our estimation anyhow.

Senator FOWLER. Dr. O'Neil, I guess I have to ask you to summarize a little.

Dr. O'NEIL. All right. The points—principal points are that we see an energy crisis developing. We see a catastrophic or a near catastrophic decline in R&D funding by the Department of Energy. We want to see that halted, we wanted to see that reversed, we want to see it brought to a level where the research and development community in concert with industry and government to really develop the commercialization of the technologies which we have invested so much money in over the past decade.

Principal areas that we support, that we spoke to this morning, are solar thermal, solar photovoltaics and biomass energy. And we urge your support in the Senate and those of your colleagues to see that this security of the Nation is guarded by an adequate renewable energy policy.

Thank you.

[The prepared statement of Dr. O'Neil follows:]

Testimony of
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Before

The Honorable Wyche Fowler, Jr.
Vice-Chairman, Subcommittee on
Energy Research and Development
Committee on Energy and Natural Resources
United States Senate

At Hearing in Atlanta, Georgia

on

13 July 1987

EXECUTIVE SUMMARY AND RECOMMENDATIONS

- Another energy crisis is predictable. U.S. import of oil is again rising: 60% of US oil will be imported by the year 2000, mainly from the Middle East, according to Conoco. A revitalized national renewable energy plan will reduce the impact of future energy crises.

- No national energy policy exists. GIT fully supports the initiative of Senator Fowler and the Subcommittee on Energy Research and Development in attempting to establish a rational, stable, multi-year national energy plan within national budgetary constraints.

- There exists a near-catastrophic decline in federal funding of the civilian R & D program of USDOE. Politically courageous initiatives are required to reestablish viable funding levels now.

- Of the $13.9 billion in the Administration's Fy 1988 budget for USDOE, only $94 million is allocated for solar energy and other renewables. Conservation research is cut in half, to $80 million.

- Solar thermal technology research is likely to achieve the nation's system-level targets of $0.5/kWh (electricity) and $9/MBTU (heat) if the gutting of the federal R & D budget is stopped and a national five-year plan is adopted and stabilized. Funding at a level of at least $30-40 million per annum is required through FY 1993.

- Solar photovoltaics R & D needs sustained funding if it is to achieve target costs of 6-8 cents/kWh in the 1990s and to stem the loss world markets (80% four years ago; less than 50% today). A budget of at least $40 million per annum is required.

- The demise of the U.S. Bioenergy Program at DOE must be prevented. Biomass, a vital national energy resource, meets 3% of the U.S. primary energy demand now; more than nuclear. A new program is outlined which stresses advanced conversion technology development, regional programs/university centers (cooperative, cost-shared R & D), and an innovative concepts" program. A progressive build up to a funding level of approximately $50 million per annum by FY 1993 is urged.

- Advanced Solar Manufacturing Technology of Strategic Materials. A radical new USDOE R & D program is proposed which focuses on the production of "solar-unique" strategic materials of commercial, space and military use. A plan is outlined for a university-based consortium which will leverage USDOE optimally, will accelerate the commercial development of solar thermal technology, and attract NASA, DoD, and industrial support.

- The termination of federal support for national and regional conservation programs must be stopped. Conservation technology has reduced the national energy consumption/GDP ratio by 25% in the last decade. A further reduction of 20% is achievable by the end of this century.
- The intellectual resource base for solar and renewable energy has been dispersed and dismantled with manpower scattered to new technologies; in many cases, permanently.
- The education and training of students in preparation for developing solar and renewable technologies and industry is stagnant.
- Previously-funded U.S. technology initiatives, technology and market leads in solar and renewable technologies have largely been lost to foreign competition.

Statement of Dr. Daniel J. O'Neil, Associate Director, Energy and Materials Sciences Laboratory, Georgia Tech Research Institute, Georgia Institute of Technology, Atlanta, Georgia before the Honorable Wyche Fowler, Jr., Vice-Chairman, Subcommittee on Energy Research and Development, Committee on Energy and Natural Resources, United States Senate at a hearing held in Atlanta, Georgia on July 13, 1987.

Introduction

Mr. Vice Chairman, I wish to thank you, Senator Wendell Ford, the Chairman, and your colleagues on the Subcommittee on Energy Research and Development for the opportunity to represent some of the views of the Georgia Institute of Technology as to the development of a national renewable energy policy and to summarize some recent efforts of this institution in the development of solar and other renewable sources of energy.

Let me state at the outset that this institution is unabashedly protagonistic to an initiative by your committee which will stem the near-catastrophic decline in federal funding of the civilian R & D program of the U.S. Department of Energy. The budget slashing activities of the 80's (see Figure 1 for a representation of the decline in a federal solar R & D program), while initially acceptable for purposes of containing the federal deficit, have clearly exceeded the bounds of prudence. Our country cannot further mortgage its energy and economic future for short-term, pragmatic political gain.

The Administration's proposed FY 1988 budget continues to demonstrate little enthusiasm for energy issues. Defense-related activities account for $8.0 billion of the $13.9 billion requested for the Department in the budget. In contrast, the funds for energy R & D are $2.9 billion. The latter figure is deceptive, masking serious policy deficiencies. In an alarming distribution of funding support, the budget reflects a fixation on magnetic fusion energy funding and nuclear power research. Other forms of energy take a beating.

Fossil energy R & D would drop from $302 million to $169 million; conservation research would be cut in half, from $162 to $80 million; likewise, electrical energy systems and storage would fall from $28 million to $14 million; and solar and other renewables would only receive $94 million, a loss of $54 million. To put the latter figure in personal perspective, the proposed national budget for solar and renewable energy R & D in 1988 is less than the total R & D expenditures of the Georgia Institute of Technology in FY 1986.

As a nation we seem again to be playing with fire - burning the stored solar energy contained in oil and natural gas as if the current low prices signal a return to inexhaustible supplies. Lost on the general public is the fact that a continuation of present trends will lead to a nationwide trauma at a later date. Because of long time constraints in developing energy sources, the United States can no longer avoid complacency. Political courage is needed now.

Energy projects, including research and development, are inevitably long-term affairs. They need to be matched by long-term policies and regularity of practice. Despite the current short-term respite from petroleum crises, the threat is clear. A new Conoco report estimates that in the next 13 years, U.S. oil imports will rise to 11 million barrels per day (mbd) from only 4.3 mbd in 1983. The U.S. will be importing about 60% of its oil, mainly from the Middle East. Well ahead of that point, the point would be set for a gigantic price squeeze. The question has been raised, "with a huge deficit in international trade, how would the United States pay for oil imports?" It is not only desirable but essential that our government institute a sound energy policy which can endure over decades and which is grounded in a portfolio of energy options, important among which are conservation and renewable energy technologies.

In the next several sections. I will address the status and potential of several critical solar and renewable technologies which hove near elimination due to the non-sustaining levels of federal R & D funding.

Solar Thermal Technology

In 1971, long before the first Mideast oil embargo, Georgia Tech researchers became the first U.S. scientific team to conduct experiments at the world's largest solar furnace in France. By 1977, the Advanced Components Test Facility was built on our campus and has been continually operated on behalf of the U.S. Department of Energy. We have been intimately involved at all stages of the development of solar thermal technology with private industry, university and government laboratories as well as with an international community. We have seen the development of solar thermal technology rapidly climb towards the system - level targets for the mid-to-late 1990's of $0.5/kWh (electricity) and $9/MBtu (Heat). In addition to Solar Thermal Power Industry, a new cadre of companies, much more broadly based and drawn from aerospace (including space commercialization interests), advanced materials, and the specialty chemical industry, are beginning to be attracted by the prospects of solar-unique products and processes using solar thermal technology. Sadly, despite the technical and cost reduction achievements of the U.S. solar thermal program which has given the U.S. a marginal worldwide lead over the USSR, there has been a wholesale closure of developing U.S. businesses in this field for lack of government participation. What is disturbing is that this young industry, with only a limited financial base, had managed to match 30 cents from its own funds for each one dollar of federal support provided for R & D. It is incredible that the U.S. government's cumulative investment of over $1000 million in this technology and industry's cumulative investment of nearly $300 million is expected to be sustained by a proposed $14 million USDOE program in FY 1988.

There exists a 1986 USDOE-approved multiyear plan which was formulated conscientiously by USDOE program managers in collaboration with industry, national laboratories, and the universities. It calls for a sustained level of funding of at least $30 million for five years for solar thermal technology. The Solar Energy Industries Association (SEIA) has also proposed a not-incompatible national plan for solar thermal energy R & D with a level of funding set at $40 million per annum. Georgia Tech supports the basic elements of these plans and urges their implementation through cooperative ventures involving industry, the universities, and national laboratories. It is important that the performance of R & D be distributed to take advantage of our national scientific resources. (At present over 40% of the solar thermal budget is concentrated in national laboratories, an artifact of the present limited sources of funds primarily). Georgia Tech endorses the following recommendation of the Report of the Solar Panel of the Energy Research Advisory Board to the United States Department of Energy, December, 1985 (DOE/S-0039):

> "Reasonable diversity in laboratory participation in research, along with continuation or even increases in the base of university and industry research activities, must be maintained to provide adequate opportunity for collaboration, competition, creativity and technology transfer and yet assure an efficient and effective use of limited resources."

Solar Photovoltaics

While solar thermal technology holds the "world-record" for conversion of sunlight to electricity (31%, using a U.S. parabolic dish-Stirling engine module), solar photovoltaics is making significant strides due to advances in materials technology.

The commitment of U.S. industry is evident to us at Georgia Tech where our Solar Photovoltaics Program is supported with contracts in excess of $one million from the Electric Power Research Institute and four private firms.

It is essential that the USDOE research program be buttressed if the solar PV industry is to meet cost reduction estimates and achieve efficiencies judged essential for generating power at a cost of 6 - 8 cents/kWh in the 1990's (constant 1986$). Key technological issues remain and industry - university - government cooperative ventures are needed; can PV cells actually be manufactured for about 20 cents per peak watt of rating? Can they be made to last for the 20- 30 years typical in traditional utility life-cycle economic analyses of alternative power technologies? Can the research developments of the solar thermal technology program on concentrators be used to produce higher (26-28%) efficiencies consistently with PV cells?

The potential to capture world leadership in PV technology is slipping away due, in great measure, to federal R & D cutbacks. The US photovoltaics industry held 80% of the world market just four years ago. Today, the US PV industry has barely half the market while the Japanese are reaching for world dominance in the technology. In 1985, the Japanese for the first time surpassed the U.S. in photovoltaic module production. Georgia Tech concurs with the U.S. industry estimate that greater than $40 million per annum of sustained core funding by USDOE is required if the nation is simply to maintain its competiveness in the world market for PV Technology.

Biomass and Waste Energy Technology

The Administration's R & D budgetary request for biofuels R&D of $10,655,000 for FY 1988 is indefensible. It should be rejected. It will destroy the remaining few promising research and development projects and eradicate any residual competitive position which U.S. industry might have during the last several years of government budget slashing.

This program area deserves careful Congressional and Executive attention at the federal level. Management changes, low morale and the absence of any clear national plan for biomass and municipal waste technology has made this program an easy prey for budget-cutters who ignore both the actual current contribution (greater than nuclear) and the potential future contribution of biomass and wastes to our national energy demand.

Biomass, the plants and wastes which contain photosynthetically stored solar energy, already contribute 3% to the Nation's primary energy demand: wood fuels provide 1.2 million barrels of oil-equivalent (BOE) each day; octane-enhancing alcohol fuel provides 32,000 BOE/d; electric power from municipal solid waste combustion plants, 8,200 BOE/d; and methane from solid waste land fills at 2,400 BOE/d. The potential contribution of biofuels to the U.S. primary energy demand is conservatively estimated to be 8.0 million BOE/d, or about 2% of total energy consumption.

Among the clean and renewable technologies biomass and wastes have the unique capability of supplying liquid, gaseous and solid fuels to all four sectors of the U.S. energy economy - the residential, commercial, industrial and transportation sectors.

It is the observation of the Georgia Institute of Technology that the continual reductions of the USDOE biofuels energy systems budgets for the last several years is:

(1) decimating the already-depleted university research programs
(2) isolating "research" activities in one or two national laboratories at "bare-bones" or "window dressing levels"
(3) dismantling and dispersing core teams of veteran biomass

researchers and technologists
(4) eliminating the training and education of students in preparation for an emerging technology and industry
(5) driving committed U.S. researchers and industrial technology to seek foreign research and commercial development support
(6) surrendering previously-funded market and technology leads to foreign competitors
(7) preventing the development of a viable, let alone competitive, U.S. biomass and bioenergy industry now or in the future

The Georgia Institute of Technology, an established leader in bioenergy and biomass conversion research, since well before the oil crises of the 1970s has been intimately involved with virtually every aspect of modern biomass technology development (alcohol fuels, pyrolysis, gasification, anaerobic digestion, etc.) with private industry, university and government laboratories, and with the international community.

Our funding has been continually eroded in the 1980s due principally to the retrenchment of the U.S. government support for the multiple technological process which characterize biomass and municipal solid waste conversion technologies. Only a handful of universities in the U.S., like Georgia Tech, have battled to keep technological R & D alive in this field of national importance.

We have tried to use a variety of practical devices to ensure the continued development of two of the GIT-designed biomass technologies which clearly have longer-term commercial potential for U.S. industry, domestically and internationally.

o The Georgia Tech Entrained Pyrolysis Process, which is patent-protected and has been developed with USDOE, is capable of producing a biocrude oil from wood waste at $16/BOE, i.e., at the current selling price of crude oil, and at optimal yields of 60%. We are researching new proprietary GIT catalysts, developed at Georgia Tech with industrial cost sharing, for direct conversion of the biocrude oil to gasoline-quality liquid biofuels. Our funding is again threatened with termination this year, despite major progress each and every year of our R & D effort.

o The GIT Lignocellulose-to-Ethanol Process. Georgia Tech developed a process for biorefining wood and other (non-food) biomass residues into its components, producing fuel alcohol and a pristine lignin by-product. The project and a designed pilot plant were terminated prematurely in 1981 by DOE despite a high level of demonstrable industrial interest. In recent R & D at Georgia Tech, sponsored by the USEPA, a mass volume use for lignin has been identified which can significantly enhance the economics of the process which has both international and domestic markets.

> Limited funds at both DOE and EPA prevent the timely development of this biomass technology, which has a potential for producing fuel grade ethanol at less than $1.00/gallon.

GIT urges not only an increase in R & D funds for biomass and wastes technology research, development and (cost-shared) demonstration but also a redistribution of funds within the budget according to the following allocation:

Biomass Conversion Technology	40%
Biochemical Conversion Technology (incl. Alcohol Fuels)	30%
Regional Programs/University Centers	20%
Innovative Concepts	10%

R & D on biomass production research should be eliminated and that responsibility transferred to the U.S. Department of Agriculture. The "Regional Programs/University Center" line item will foster cost-sharing, cooperative ventures with industry and the states. "Innovative Concepts" will guarantee an infusion of latent, but promising, new technologies (products or processes) of a high-risk nature to be added to the national portfolio of biomass and waste energy technologies - particularly from small businesses, individuals, and non-profit organizations (perhaps, in concert with the SBIR and NBS/OER Programs).

A staged build-up to $52M per annum at a rate of 10% p.a. in funding from FY 88 to FY 93 is recommended, e.g., $32M, $35M, $39M, $43, $47M, and $52 (1987$) in order for the U.S. to reassert its competitiveness internationally and to catch-up with programs of the European Economic Community, Japan and the Soviet Union.

Advanced Solar Manufacturing Technology of Strategic Materials

I wish to propose a radical new concept for inclusion in a national renewable energy program, that is, a separate program for the development of unique solar-assisted materials and chemical manufacturing processes (resistive heating, induction furnaces, etc.), energy-draining though they are, but will take advantage of the presence of both photon (light) energy and the thermal energy in concentrated sunlight to create entirely new and unique products of "high-value added".

Our Energy and Materials Sciences Laboratory has recently achieved technological breakthroughs in the development of "solar-unique" processes. We are currently using the Georgia Tech Solar Furnace, which concentrates light to the intensity of 9,000 "suns", to search for processes that can only be achieved with the concentrated flux of sunlight. Several unique and patentable materials and processes have emerged in little over one year of research. They include single crystals of ultrahigh strength and purity called "ceramic whiskers and novel grades of oxidation-resistant carbon and graphite fibers. These products are classified as "strategic materials" in the United States and are vital to our aerospace, space and military programs.

U.S. research initiatives in this field are limited to a small percentage of the current solar thermal budget and are, thereby, confined to two or three research groups (Georgia Tech, University of Houston, and SERI). Recent evidence from the Soviet literature indicates that the USSR has been aggressively pursuing the use of concentrated solar energy in advanced materials technology with an accelerating program being defined in 1983. The Ukrainian Institute of Materials Technology has recently reported on the use of concentrated solar energy to produce amorphous-metal materials, a new class of materials with unusual properties which are of interest for many areas of science and technology.

As part of the USDOE program, we would propose the establishment of a national university-based Center for Solar Materials Processing, organized as a consortium of industry, university, and government research laboratories which, through cooperative R & D and spin-off activities, will accelerate the technological development of solar energy by designing and demonstrating commercial products for which markets already exist. The Center will attract "non-solar energy" businesses such as the advanced materials companies (steel, metals, ceramics, composites, etc.) and the support of other government agencies (DoD, NASA, etc.), thereby leveraging the limited USDOE funds substantially.

The Center would conduct basic, applied and commercially-oriented R & D on a generic basis, the results of which will be made available (for example, through non-exclusive, non-transferrable, royalty-free licenses) to member companies of the consortium (foreign participation would be prohibited); it will also conduct R&D projects on a contractual basis with sponsors which may not be members or associates of the consortium.

We would propose that the Center be established to operate on a non-profit (non-loss) basis with initial funding by USDOE at a level of $2 million per annum for a maximum of five years after which time the Center is expected to be self-sufficient. The total USDOE program budget could be operated at a level of $4.5 million per annum through FY 1993.

Energy Conservation

Energy conservation should be treated as a tangible national resource. its contribution to meeting the national energy demand should be assessed as a "credit" on the supply side. From 1977-1987 the United States has achieved a 25% reduction in energy used per dollar of GNP. The federal energy conservation program initiated in the late 70s will undoubtedly be regarded by future historian as one of the great achievements of the Center Administration.

In its concerted assault on the civilian R & D program of

USDOE, the General Accounting Office recommended the termination of the Residential Conservation Service Program by 1989. The Administration's FY 1988 budget proposes to eliminate the Conservation Grants Program which has provided funds to state and local governments to implement energy conservation measures. Yet, in 1984 the Department of Energy reported that 86% of U.S. single - family homes were less than fully insulated. The Atlanta-based national Association of Energy Engineers reported this year that professional audits have not been conducted on 89% of all buildings and that 97% of commercial buildings do not have computerized systems to control heating and cooling.

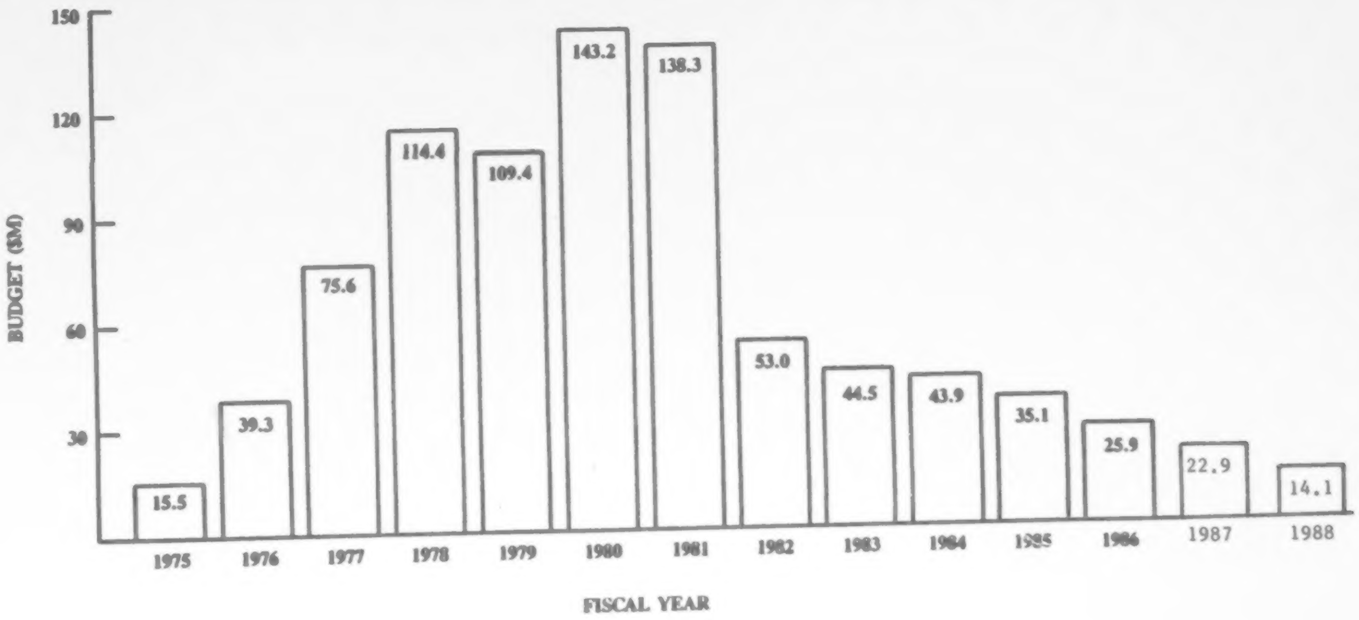
The mission to develop and implement new conservation technology and practices is simply incomplete, despite the demonstrable positive impact of the USDOE conservation program. Based on International Energy Agency data the U.S. reduced its energy consumption-to-Gross Domestic Product (GDP) ratio from 1.14 tons of oil-equivalent per $1000 GDP (in 1985$) in 1973 to 0.90 TOE/$1000 in 1984 with a forecasted reduction to 0.72 TOE/$1000 by the year 2000. This immense oil savings potential can hardly be achieved without ~~a~~ consistent national policy on energy conservation.

One of your committee's concerns, rightly, focuses on assuring the competitiveness of U.S. industry in world markets. This sector accounts for approximately one-third of the Nation's total primary energy use as a state technological university with a mandate to contribute actively to the economic welfare of the State of Georgia, the Georgia Industrial Energy Extension Service (IEES) has been operated continuously since 1977 under sponsorship of the Georgia Office of Energy Resources through a grant from USDOE. That program, which will be described more fully in other testimony, has resulted in almost $500 million per annum in energy cost savings by Georgia industry. Georgia Tech urges the continuance of this program and its adoption as a model of success for other states and regions, with a return to a stable level of federal funding at USDOE.

Conclusion

We at the Georgia Institute of Technology pledge our continuing support to assisting in the development of a secure national energy policy and have welcomed the opportunity to share our views on selected topics in the field of renewable energy technologies. Thank you.

SOLAR THERMAL TECHNOLOGY BUDGET HISTORY



Senator FOWLER. Thank you very much for your testimony and the comprehensiveness of the testimony.

We have the TV microphone now, Mr. Jones. I will have to say something provocative to you.

Mr. JONES. You might have picked the wrong person, wrong subject.

Senator FOWLER. We are delighted to have Mr. Dwight Jones, Principal in the firm of Jones, Nall & Davis from Atlanta. Welcome. Proceed as you wish.

STATEMENT OF DWIGHT H. JONES, P.E., PRESIDENT, JONES, NALL & DAVIS, INC.

Mr. JONES. Thank you. I want to thank you for the opportunity and I would like to say it is gratifying to know that someone in Washington is interested in the energy resources of this country and that I tend to agree with everyone else that at some point in the future—and I do not believe it is in the next decade, I think it is in a couple of years—we will see more emphasis required in energy conservation.

As a mechanical engineer and as a principal of an engineering firm, my responsibilities and day-to-day happenings are in buildings. So what I am going to do is kind of bring the focus of what we are talking about now to actually energy conservation in buildings and the possibility of using alternate energy sources in buildings.

There will be many other people who will speak to the amount of funding required for research and development of the kinds of technologies that I believe could be implementable in energy systems being built.

I have been in this business for over 25 years and over that 25 years I have seen many kinds of systems installed and in the mid-seventies and late seventies, participated in the design of many of the energy systems in the United States; particularly here at this building, the solar energy collection system downstairs on the low-rise roof of this building, the passive solar which is on the south face of this building and the energy conserving HVAC systems and lighting systems in this building.

Many of those systems were proliferated by the energy conservation design criteria that the General Services Administration issued as part of the funding processes for Federal buildings. The old 55,000 BTU per square foot per year requirement for energy.

Senator FOWLER. When was that?

Mr. JONES. That was in the late sixties, actually started in the seventies, is when it became a high priority, by 1973 particularly.

And because a secure and diverse supply of energy in the Nation is in the best interest and because the Federal Government is the largest consumer of energy in the United States and because the Federal Government has the largest ongoing building construction program and building renovation program in the United States, I believe the Federal Government should promote a program or research, development and demonstration of cost effective renewable energy and energy conservation technologies.

What I am saying to you is we are looking to you as a leader in this and the Federal building process is a significant leader in that area. I do not have the figures, but I can state probably that the Federal Government spends as much money or more money than any building entity in this country.

This promotion should be by issuing stringent energy consumption targets—I am talking about energy budgets for all buildings which have Federal Government funding. This would require the architects and engineers to meet energy conservation goals without constraining the design process. I think you have probably had enough contact with architects and engineers to know they are very fickle people, they do not want to be constrained by prescriptive guidelines. You have to have certain amounts of insulation, you have to have certain amounts of other things.

These energy targets have already been developed by the Department of Energy under the old Building Energy Performance Standards Program. This program was developed for the DOE by the American Institute of Architects in the seventies, and there were surveys and analyses and computer simulations done of buildings as designed and buildings that would implement energy conservation measures that were viable at the time.

Also, I think in the building cost budget for Federal projects, there should be a specific criteria for financial viability of energy conservation measures. What I am proposing to you when we do buildings is that there is always a budget line item and in that budget there should be energy conservation and there should be financial criteria set up to consider energy conservation measures that would be viable. Specifically let us talk about solar systems and that would qualify under the alternate energy systems, which would be a 20-year payback, which would be within the useful life of the building generally.

We have a specific energy conservation budget of $200,000. We develop the energy conservation measures to provide photovoltaics for demand control for the building or for some other energy conservation measure. We determine that the cost effectiveness of that would be a payback in five years or six years and the cost of it is $150,000. We would then take that line item out of the energy contingency fund, put it into the budget that says this is an amount that is now going to be applied to this building and it meets the energy conservation criteria. There is still $50,000 remaining in that energy contingency. If there are no other energy conservation measures that meet that contingency, like any contingency it is then refunneled back to the government budget somewhere—God knows where.

But at any rate, the reason I am saying that is there is no mechanism now for the engineers and the architects to come up with cost effective energy conservation measures. There is no criteria that says that, so it is down to a level where people are selling energy conservation measures in buildings that may not be the most appropriate, may not be in the best interest of the Federal Government.

And I am proposing that for certain types of measures, there are payback criteria. And I am convinced we should use simple payback. I have been involved in many projects where we used return on investment or any other financial criteria, and what we ended up doing was arguing with the accountants as to what the return on investment should be. A simple payback is the most reliable criteria, and understandable criteria.

These types of measures should have these criteria. I am saying building envelope energy conservation measures, better glazing, shading, should have a five year payback. Building systems, I am talking about mechanical systems, HVAC systems, lighting systems, should have a five year payback. Alternate energy systems, because they are at this point not commercially cost effective, I think they should have a 20 year payback.

When we reach the point where commercialization of these systems is viable, then I think that alternate energy system should go down to five years.

You will find now in the private sector, this is one of the biggest problems with energy conservation today, the majority of people who are building commercial buildings are willing to look at anything that will payback within one year. In a corporate setting, three to five years and in a government setting, something between five to ten years. So there is a constraint on energy conservation measures and I think that is one of the reasons there is a lack of proliferation of alternate energy sources in commercial buildings.

Senator FOWLER. Since yours, like every other profession, does not like to have Federal standards mandated on them, do your colleagues actively promote energy conservation in the design of the buildings without being told to do so?

Mr. JONES. Unfortunately there are only a few of us who do. Without the emphasis, without the publicity, without the criteria being developed by the corporate users or the developers who are developing buildings, there is a small number of people who actually still do energy conserving design. I will say though that some of the techniques that were developed in the seventies and eighties are now standard within the energy design of buildings. The higher performance glazing has become a standard in the design of buildings and its cost has come down significantly because we are using more of it, economies of scale.

So I think there have been some advantages and reduction. Some of those energy conservation measures are now standard design practices. But the true measures that we are going to find, the alternate energy, the photovoltaics are not going to be implemented without further study, further research and proliferation by corporate users.

I would make one other statement about energy conservation measures in buildings, one of the things we have found is there are not one or two major energy conservation measures that save energy in a building, there are a number of small ones that have to be pulled together.

This building is a prime example of that. This building has a 100,000 gallon chill water storage system down in the basement outside under the grass—excuse me, 300,000 gallon chill water storage system that is used for demand control. It is stored at night off-peak and then we use the chilled water during the day to reduce energy consumption in the building. That would be an opportunity in areas, particularly like Washington, that has a time of day rate where electricity at night is 2.5 cents a kilowatt hour and during the day it is seven and eight cents a kilowatt hour. So it is important as a technology and Georgia Power is doing a lot to document that and to prove its viability. In addition of course the solar system on the low-rise roof of this building, the 24,000 square foot concentrating solar collection system is the largest solar energy collection system for building cooling in the United States. It was part of the DOE Cycle 3 demonstration program and I think has been very beneficial to Georgia Power in developing their solar policy.

I would like to mention also that the DOE BEPS program did conclude that 30 to 40 percent of the energy in buildings could be reduced by using energy conservation measures and that those measures would only increase the building cost by three to five percent in building construction projects. And if you are involved in the project, you would know that three to five percent is not a significant number when you are dealing with a large building.

The way this should be funded, I am thinking that the Building Energy Performance Program, all the data that was collected, should be brought back together. I think it should be documented and I think we should develop some building energy performance standards. I think those standards will become the standards of the private industry when the 55,000 Btu per square foot per year number came out, there were all of the corporate users and some of the developers in commercial buildings were looking to that as a guideline. We were successful in 35,000 BTU per square foot per year for this office building and Atlanta sees about a 45,000 BTU per square foot per year as a standard building design.

Under Section 7 of your Bill, the Renewable Energy and Energy Conservation in Federal Buildings, I am proposing that that is where funding for the energy conservation program in Federal buildings, and that the BEPS program be re-funded and under any circumstance, $250,000 is going to be way low of whatever you are trying to do in the energy conservation field. Even though there has been a widespread development of energy conservation in buildings, we are not yet implementing the alternate energy systems that need to be implemented to significantly reduce dependence on oil in this country.

Also, funding for the Energy Efficiency Contingency budget line item, that can come out of the standard budget, that can come out of the DOD or anybody else's budget for producing a project. The only thing that has to be done is it has to be developed as a line item that says one percent or five percent of this project will be designated for energy conservation. It is not that hard and it really would not require that much more funding, just a little more effort on the DOD or whoever happened to be funding the project.

In summary, I think our Federal energy policy should be broad enough in scope to provide for a broad based stable research, development and demonstration program of renewable energy and energy conservation technologies which meet all of our Nation's needs, but it also should be specific enough to pinpoint market segments both nationally and internationally which would provide enough return to justify our investments. Those market segments have to be things like heat pipes. A minute ago you were talking about where would we use heat pipes. Any place that we provide humidity control, particularly humidity reduction, is a good cost effective application of heat pipes—hospitals, recovery rooms for hospitals, operating rooms, delivery rooms for hospital, industrial processes where we are trying to dehumidify the air to improve the process. So there is a widespread use for heat pipes and in the hospital business there is no other business under more cost pressure.

Thank you.

[The prepared statement of Mr. Jones follows:]

PREPARED STATEMENT OF DWIGHT H. JONES, P.E.

SUBMITTED TO THE

SUBCOMMITTEE ON ENERGY RESEARCH AND DEVELOPMENT
OF THE
SENATE COMMITTEE ON ENERGY AND NATURAL RESOURCES

JULY 13, 1987

Mr. Chairman, members of the subcommittee, I am Dwight H. Jones, P.E., President of Jones, Nall & Davis, Inc., an Atlanta based mechanical and electrical engineering design firm. As an engineer I am most interested in how research, development and demonstration of renewable energy and energy conservation technologies will affect the built environment.

I have had the opportunity over the last 25 years to design and oversee the construction of projects including single family dwellings, multi-family dwellings, commercial office buildings, hospitals, churches, industrial plants, shopping centers, colleges, schools, etc. The common element of these projects was their requirement for some form of energy to render the project useful.

You will hear other testimony today and at other hearings from experts in the energy field. These people will provide you with testimony relative to the direction and funding levels for research and development of renewable energy and energy conservation technologies. My testimony today will indicate to you what actions the Federal government should take to promote energy efficiency in buildings.

Because a secure and diverse supply of energy is in the Nation's best interest and because the Federal government is the largest consumer of energy in the United States and because the Federal government has the largest ongoing building construction and building renovation program in the United States, the Federal government should promote a program of research, development and demonstration of cost effective renewable energy and energy conservation technologies.

This promotion should be by issuing stringent energy consumption targets (energy budgets) for all buildings which have Federal government funding. This would require Architects and Engineers to meet energy conservation goals without constraining the design process. These energy targets have already been developed by the DOE under the Building Energy Performance Standards (BEPS) program. This program was developed for DOE by the American Institute of Architects. Also a line item in the building cost budget should be included for energy conservation. Specific criteria for financial viability of energy conservation measures should be developed, then specific energy conservation measures could be analyzed to determine if they meet that criteria. This criteria should be expressed in terms of simple payback on investment. This criteria should be as follows:

Type of Energy Measure	Simple Payback
1. Building Envelope	5 Yrs.
2. Building Systems	5 Yrs.
3. Alternate Energy Systems	20 Yrs.

Once the energy conservation measure is proven to meet the payback criteria the cost for that measure is removed from the energy conservation contingency budget line item and is included as a component of the new building budget. The energy conservation contingency budget line item will provide the Architect and Engineer the freedom of creativity and encourage the use of significant energy conservation measures. The DOE BEPS program concluded that the use of alternate energy sources and energy conservation technologies could result in energy cost savings of over 30 to 40 percent with an increase in building construction cost of only 3 to 5 percent. The energy conservation contingency budget line item will be different depending on the size and magnitude of the project, but the line item should always be within 1 to 5 percent of the total construction cost.

Also the DOE BEPS program concluded that the thirty to fifty percent reduction was not as a result of one or two major energy conservation measures, but the result of a combination of many integrated energy conservation measures which when applied together resulted in significant savings. These energy conservation measures included high performance glazing, passive solar systems, solar thermal energy systems, electronic building automation and control systems, energy storage systems, improved thermal transmission values, high efficiency chillers, pumps, cooling towers and boilers, variable air volume air delivery systems, electronically controlled variable flow hydronic pumping systems, etc. Most of these energy conservation measures had been tested and proven effective under one or more of the Federal government building programs and then were replicated in the private sector.

For example the building we are in today, the Georgia Power Corporate Headquarters Office Building, is one of the most energy efficient commercial office buildings in the world. The building as designed will use about half the energy of any comparable building in Atlanta. The 24,000 square foot concentrating solar energy collection system is the largest application of solar thermal energy for building cooling in the USA. The energy efficiency of this building is as a result of a design process which included an energy consumption target (energy budget) and a rigorous set of financial criteria for payback on investments in energy conservation measures.

The results of the Federal government promoting energy conservation in buildings will include new energy standards being developed by the private sector. These new standards would require more energy efficient designs by Architects and Engineers, new energy efficient equipment and components by manufacturers, and development and procurement of renewable sources of energy.

Funding for completion of the development and dissemination of the energy targets should be requested under SECTION 7. RENEWABLE ENERGY AND ENERGY CONSERVATION IN FEDERAL BUILDINGS of the proposed bill. Funding request should be increased to at least $1,250,000.

Funding for the energy efficiency contingency budget line item should be funded as a part of the standard capital investments and improvement budgeting process.

Our Federal energy policy should be broad enough in scope to provide for a broad based stable research, development and demonstration program of renewable energy and energy conservation technologies which meet all of our nation's needs, but it also should be specific enough to pinpoint market segments both nationally and internationally which would provide enough return to justify our investments.

Senator Fowler. Mr. Jones, I thank you for the specificity of your testimony. Due to your Billy Graham rapid fire delivery, I think we have to call a break before our reporter has a heart attack.

Mr. Jones. I thought we had ten minutes.

Senator Fowler. You did it well. Thank you so much.

The next witness is Mr. Jeff Tiller, President of Southface Energy Institute in Atlanta.

STATEMENT OF JEFFREY S. TILLER, PRESIDENT, SOUTHFACE ENERGY INSTITUTE

Mr. Tiller. I want to than you for inviting me here and I want to thank you personally, Senator, for your support over the years for renewable energy resources and energy conservation. I do not know if you remember, but in 1978 you were at our organization's first press conference as part of what we called Georgia Sun Day. I remember your child was there as well and as a dad after that, I recognize now the importance of preserving critical energy resources more than ever. We all think about the Gulf over there and have a fear of our kids being taken over there to serve in some capacity in the future, that we hopefully are able to prevent.

Over the past few years, I think we have seen conservation not only ignored but also maligned by our leaders. We find in both the state as well as the Federal Government an interest that at times is almost anti-solar and anti-conservation. But we find among the grassroots a number of the projects that we do, we go out and meet with people in a home show or whatever, and we find interest stronger than ever. We just did some programs in New Orleans in which we thought gee, they do not really need as much insulation down here as we do in Atlanta, and these guys we talked to, their houses were bulging with insulation down there because they recognize the importance of conservation as a money-saving item; also a comfort producing item. Too often people have assigned the label of conservation as a more sweaters and uncomfortable in the winter type of thing, when we look at it as a comfort producing type of technology.

I just received the proposed legislation late last week so what I would like to talk about today, to sort of weave together my testimony and some of my response in reading through the legislation.

Senator Fowler. That would be very helpful to all of us.

Mr. Tiller. First of all, we are very excited about such legislation, as everyone here is, I am sure. In research and development, as everyone has pointed out, we are falling behind. We have some special concerns, a lot dealing with building energy technology, the whole area of building sciences. We feel in the applied phase of this, meaning building houses and building commercial buildings, as Mr. Jones has said, we are backtracking. We find more and more homes built now in our region with single pane glass, which we think is very unfortunate. We find, say with the state energy code, first of all it is not being enforced so a number of buildings are being constructed that do not meet the state energy code. Also, some programs such as Georgia Power's good cents program, which we think is a very good program in trying to get the idea across to builders and give them incentives to build energy efficient homes, actually their good cents program does not meet the state energy code, in that buildings can be built and are being built that qualify for good cents that do not have insulated slab floors. We think research into these—there almost like miniresearch projects, is a key area. I know right now the Governor's Office on Energy Resources is able to do research into slab insulation and hopefully prove to builders that it does save energy, because that is the contention of a lot of builders, they do not want to insulate the slabs because it is relatively difficult to do for them.

We find a lot of other areas that qualify as these mini-research projects. The idea of vapor barriers on homes, people are putting them on the inside, on the outside, they are not putting them in, they are putting them on both sides. We have talked to the U.S. Forest Products Lab, which has done considerable research on the topic in our region and Houston, Texas, which is a very hot and humid climate. Other universities have also done research. There is no consensus, people do not know—builders do not know where to put a vapor barrier and homes are built now that are going to suffer moisture problems over the years because they are putting them where they should not be. So we feel like that should be a critical area.

Other areas include infiltration control. There is a whole growing concern that people are going to seal up their houses too tight and suffocate in them because of air quality being degraded. When and where this is a problem, what are some—doing research into low-cost technologies to provide adequate ventilation and not suffer energy consequences from it for infiltration control and protect human health.

Along with human health, the whole issue of new insulation products. There are foam sheathings available which may endanger human health. No one has done a lot of research on it. So that is an area for concern.

We find a lot of research is being done in some areas, such as windows and lighting. The window industry is booming with all sorts of energy conserving window products, using low emissivity films, a special film that basically keeps heat energy inside the house. I am sure there are many research topics that could be looked into by the Federal Government in that area. However, there are other areas we think are not being addressed, such as the vapor barrier issue and infiltration control issue.

There is a whole other side of it which we view as consumer protection. Right now in the south, a whole new product line called radiant heat barrier are being investigated and in this area the idea is you put a foil layer in your attic, it reflects heat energy off your insulation in the summer time and keeps your house cooler. We find it is a promising area; however, there are companies now selling products for a dollar a square foot and doing heavy marketing techniques. We have concerns about these techniques because we saw them being used with solar collectors for water heating several years ago. We think, first of all, research is being done on radiant heat barriers by the Florida Solar Energy Center, TVA and universities. We think the Federal Government should also—well of course with TVA they are supporting some of the research at

TVA, I am assuming—I do not know exactly how TVA's budget works, but that is an excellent area for research and we think dissemination of the information to consumers because right now, as we sit here, people are being over-sold on these products.

Infiltration barriers, the idea here is you wrap the house with a special membrane that is actually porous to vapor, to water vapor. The manufacturers themselves claim great energy savings. We have questions about how much you save with these infiltration barriers. We know of no objective independent research being done.

There are many other areas like this. What we would kind of like to see is a consumer building energy lab or something along those lines, and in your—in the legislation there was a proposal for the regional factory housing area, having three regions. We think the regional approach is vital because building technologies, different things are appropriate for different regions. We can see a board working with this lab that would identify research issues and come up with, I would view, fairly inexpensive research topics to try to say let us get the answer to this and disseminate it to builders and consumers throughout the region.

We think something needs to be done with energy codes. We think the state is the appropriate level, but they are just not being enforced. What can be done to encourage enforcement of energy codes. Could it be some assistance from the Federal Government to help provide code officials with extra money, basically, to hire people to enforce the code, but that is the main limiting factor.

In your ideas on the joint venture projects, I was very excited about those. With the factory housing joint venture project, first of all that is—you have really identified a booming area, we see more and more interest in that area. But we would hope, and once again this is the idea of this regional center, that it could be expanded in some way to deal with issues for houses being built today. Perhaps the concept of it was a bit different and these could be two independent or linked organizations, but some way to do research on critical issues in the building sciences area.

Going into the other research topics, I think we have heard a lot of talk about photovoltaics, solar thermal, other areas. One thing I would say is to let the experts do the research. I have been in the research area actually at Georgia Tech for awhile and I have seen a fair amount of funding in the solar area in which people who were great at getting grants and great at doing military or aerospace projects, got money even though people who built say solar collectors and done it well were out there building them in the private sector. I have seen failures of solar collectors built by aerospace companies when someone who was specifically a collector company could have built it and done an excellent job, but they did not have the sophistication to write the grant or the contract—or the proposal to do it.

With photovoltaic research, one area that has not been mentioned is the ancillary technologies, like batteries, inverters. We did hear some mention of concentrators. I think a lot of research is now going into solar modules but I am not sure how much is going into batteries and the other areas. And we view these as critical because it can end up having a system where you reduce the cost of the modules down and the batteries may be the limiting factor in the economics.

Solar thermal, the heat engine idea, including that, Stirling engine and the Brayton cycle engines that been mentioned earlier. That is the ancillary technology, not just working on the heliostat, but what it powers.

Dollar amounts on your proposed bill, in the region you are in, you hear a lot about PV's and solar thermal, not as much about wind and not much at all about geothermal. And my own preference would be to see more of the money going into PV's and solar thermal and less in say geothermal, but I am sure the dollar amounts have to be worked out politically and I am not sure nationwide how they should fall.

The idea of the balance proof of concept, I would say companies with experience once again working on those.

In general, research advisory board in working with the research in each area because we feel like a lot of times the research dollars may not be put where they are needed, so some type of board to make sure working with government, industry, state government, university and consumer, that research is being put where it will, as you said earlier, get the biggest bang for the buck.

The fuel cell program as part of the joint venture idea, I am not sure the exact implications. I know there were a lot behind the different proposals in the bill. The idea can we include heat engines, Stirling cycle engines as part of that program. The idea of considering energy storage, batteries—I am not sure of the status of flywheel research but it was an area at one time. Pumped hydro is an area that has been successfully proven already.

Using—storing energy as we are doing in this building here so we can use it during non-peak times—store it during non-peak times and use it during peak times.

In the district heating and cooling area of the joint venture proposals, we see a booming market with co-generation. We see a lot of interest in our state because electric bills are scheduled to rise fairly rapidly over the next few years. We are not sure it is justified in all cases, but we know that there is definitely a strong interest and we will see more interest in co-generation.

Senator FOWLER. I will ask you to go ahead and conclude, Brother Tiller.

Mr. TILLER. Okay. In conclusion——

Senator FOWLER. I have been at a lot of hearings over ten years in the United States Congress, but I am particularly pleased with the specificity of suggestions both on my legislation which is still being developed but also some very specific suggestions in all of these alternative areas.

Mr. TILLER. Thank you. And once again, we certainly appreciate your interest and support in these areas.

Summing up quickly, labeling we think is important. Federal buildings we see as very important, we think it should be expanded to facilities, communication towers and location, pipelines that can use energy technology. I do not know the exact requirements but let us say all Federal buildings need to install technologies that have paybacks of seven years or less, reduces the long-run deficit and increases security, helps commercialize the technology.

So in summary, we think we have the brains but we do not have the bucks right now, so we need the bucks so we can put ourselves to good work and solve some of these problems.

Thank you very much.

[The prepared statement of Mr. Tiller follows:]

TESTIMONY GIVEN BY JEFFREY S. TILLER OF THE SOUTHFACE ENERGY INSTITUTE

BEFORE THE SENATE COMMITTEE ON ENERGY AND NATURAL RESOURCES:
FIELD HEARING IN ATLANTA, GEORGIA JULY 13, 1987

WHAT IS YOUR NAME, ADDRESS, AND PLACE OF BUSINESS?

MY NAME IS JEFFREY S. TILLER. I LIVE AT 308 FERGUSON STREET, ATLANTA, GA 30307. MY BUSINESS ADDRESS IS:

SOUTHFACE ENERGY INSTITUTE
P.O. BOX 5506
158 MORELAND AVENUE, SE
ATLANTA, GA 30307

WHAT QUALIFICATIONS DO YOU HAVE TO GIVE TESTIMONY?

I AM AN ENGINEER WITH A BACHELOR'S AND MASTER'S DEGREE FROM THE GEORGIA INSTITUTE OF TECHNOLOGY IN INDUSTRIAL AND SYSTEMS ENGINEERING. I RECENTLY PASSED MY ENGINEER-IN-TRAINING EXAMINATION AND AM AWAITING WORD ON WHETHER I PASSED MY PROFESSIONAL ENGINEERING REGISTRATION IN MECHANICAL ENGINEERING (I TOOK THE REGISTRATION EXAM IN APRIL, 1987).

IN MY PROFESSIONAL CAREER, I SPENT SIX YEARS AT FORECASTING INTERNATIONAL LTD. IN WASHINGTON D.C. AND AT THE GEORGIA TECH RESEARCH INSTITUTE DOING RESEARCH ON ENERGY OPTIONS SUCH AS COGENERATION FACILITIES, CENTRAL POWER PLANT ECONOMICS, INDUSTRIAL CONSERVATION OPPORTUNITIES, WASTE-TO-ENERGY PLANTS, CENTRAL SOLAR POWER STATIONS, RESIDENTIAL AND COMMERCIAL PASSIVE SOLAR AND SOLAR WATER HEATING DESIGN, AND BUILDING ENERGY CONSERVATION.

SINCE 1980, I HAVE SERVED AS PRESIDENT AND STAFF MEMBER AT THE SOUTHFACE ENERGY INSTITUTE, FORMERLY KNOWN AS THE GEORGIA SOLAR COALITION. WE ARE A NONPROFIT ENERGY EDUCATION AND RESEARCH ORGANIZATION. I HAVE WRITTEN NUMEROUS ARTICLES AND SEVERAL BOOKS ON THE ENERGY PERFORMANCE OF BUILDINGS USING SOLAR ENERGY AND ENERGY CONSERVATION. I HAVE PARTICIPATED IN THE

DESIGN OF OVER 400 BUILDINGS USING SOLAR ENERGY AND ENERGY CONSERVATION MEASURES. SEVERAL SCHOOL SYSTEMS HAVE HIRED ME TO CONDUCT THOROUGH INVESTIGATIONS OF THE OPPORTUNITIES FOR ENERGY CONSERVATION ON THEIR FACILITIES. MY RESEARCH WORK HAS INCLUDED BOTH FIELD TESTING AND COMPUTER MODELING OF ENERGY SYSTEMS.

WHAT IS THE POTENTIAL FOR USING ENERGY CONSERVATION AND SOLAR ENERGY IN GEORGIA?

I FIND THE POTENTIAL STAGGERING. WHILE WE HAVE TAKEN MANY STEPS TO CONSERVE ENERGY OVER THE PAST SEVERAL YEARS, WE HAVE JUST BEGUN TO REALIZE THE TREMENDOUS ADVANCES THAT CAN BE MADE. IN THE AREA OF BUILDING ENERGY USE ALONE, THE ADVANCES OVER THE PAST SEVERAL YEARS ARE AMAZING. NOW WE HAVE WINDOWS THAT CAN APPROACH WALLS IN THEIR INSULATING VALUE, WE HAVE INSULATING BOARDS 1-INCH THICK THAT GIVE ALMOST AS MUCH INSULATION AS ACONVENTIONAL WALL, WE HAVE NEW DEVICES FOR REFLECTING HEAT IN HOT ATTICS TO REDUCE COOLING BILLS, WE HAVE AUTOMATED HEATING AND COOLING SYSTEMS THAT MAINTAIN COMFORT IN OCCUPIED ROOMS AND ALLOW TEMPERATURES IN OTHER ROOMS TO FLUCTUATE, WE HAVE NEW LIGHTING SYSTEMS THAT USE 1/5 THE ENERGY AND PROVIDE THE SAME AMOUNT OF LIGHT AS STANDARD BULBS....THE LIST GOES ON AND ON.

WHAT SHOULD BE THE FEDERAL ROLE IN ENERGY RESEARCH, DEVELOPMENT, DEMONSTRATION, AND COMMERCIALIZATION?

I BELIEVE THE FEDERAL ROLE SHARES AN IMPORTANT ROLE WITH PRIVATE INDUSTRY IN DEVELOPING ENERGY ALTERNATIVES OF ALL TYPES; HOWEVER, IN THE AREAS OF ENERGY CONSERVATION AND RENEWABLE ENERGY DEVELOPMENT, OUR GOVERNMENT IS NO LONGER DOING THE JOB. IN PARTICULAR, I FIND THAT A NUMBER OF IMPORTANT AREAS FOR RESEARCH ARE BEING NEGLECTED; OPPORTUNITIES FOR HELPING DEVELOP RESOURCES ARE NOW DIFFICULT TO FIND;

INCENTIVES FOR UTILIZING THESE RESOURCES, SUCH AS THE SOLAR INCOME TAX CREDITS HAVE BEEN ALLOWED TO EXPIRE; INFORMATION TO HELP CONSUMERS MAKE FREE MARKET DECISIONS, SUCH AS THE APPLIANCE LABELING PROGRAM, HAS BEEN REPEALED OR VETOED; AND ENERGY CODES, SUCH AS GEORGIA'S ENERGY BUILDING CODE, ARE NOT ADEQUATELY ENFORCED.

WHAT ARE SOME EXAMPLES OF ENERGY RESEARCH PROJECTS NEEDED?

THE FOLLOWING LIST OUTLINES A FEW OF THE IMPORTANT ENERGY PROJECTS I FEEL NEED ATTENTION. THEY PERTAIN PRIMARILY TO THE RESIDENTIAL AND COMMERCIAL SECTORS.

INSULATION:

LONG-TERM R-VALUES -- TOO OFTEN, THE R-VALUES OF INSULATION PRODUCTS ARE ONLY THE INITIAL VALUES. OVER TIME, THE R-VALUES DECLINE. OF COURSE, THE VALUES DECREASE AT DIFFERENT RATES FOR DIFFERENT PRODUCTS.

VAPOR BARRIERS -- THERE IS AS YET NO CONSENSUS ON WHERE VAPOR BARRIERS ARE NEEDED IN THE SOUTHEASTERN CLIMATE. SOME BUILDERS AND DESIGNERS FEEL THEY ARE UNNECESSARY, SOME FEEL THEY SHOULD GO ON THE INTERIOR WALL, SOME SAY ON THE EXTERIOR, AND OTHERS SAY ON BOTH SIDES. RESEARCH HAS BEEN CONDUCTED BY THE U.S. FOREST PRODUCTS LABORATORY AND VARIOUS UNIVERSITIES, BUT NO FINAL RECOMMENDATION HAS BEEN DEVELOPED THAT IS GENERALLY SUPPORTED. THE LACK OF DEFINITE GUIDELINES POSES THE THREAT OF DEGRADATION OF BOTH INSULATION AND FRAMING DUE TO MOISTURE TRAPPED WITHIN THE WALL OF HOMES WITH IMPROPER PLACEMENT OF VAPOR BARRIERS.

SLAB INSULATION -- THE GEORGIA ENERGY CODE REQUIRES THAT CONCRETE SLAB FLOORS IN CONDITIONED ROOMS HAVE INSULATION AROUND THEIR PERIMETER. BUILDERS FIND THE INSULATION DIFFICULT TO INSTALL AND HAVE QUESTIONED

THE ENERGY SAVINGS. THE GOVERNOR'S OFFICE OF ENERGY RESOURCES HAS BEEN ABLE TO FUND RESEARCH ON THIS TOPIC THROUGH THE OIL OVERCHARGE MONEY IT HAS RECEIVED. UNFORTUNATELY, THIS OIL OVERCHARGE FUNDING, WHICH HAS ENABLED THE STATE ENERGY OFFICE TO MAINTAIN MANY OF ITS FINE PROGRAMS THAT OTHERWISE WOULD HAVE BEEN CUT, WILL END OVER THE NEXT FEW YEARS.

INFILTRATION CONTROL

INFILTRATION BARRIERS -- THESE CONTINUOUS SHEETS GO ON THE OUTSIDE WALL JUST UNDER THE SIDING. THEY HELP PREVENT AIR LEAKAGE THROUGH THE WALL. SOME PEOPLE CONTEND SUBSTANTIAL ENERGY SAVINGS (PARTICULARLY THOSE WHO SELL THE PRODUCT), OTHER PEOPLE QUESTION WHETHER THESE PRODUCTS ARE REALLY WORTHWHILE. INDEPENDENT RESEARCH IS NEEDED TO VERIFY WHICH, IF ANY, CONDITIONS MAKE INFILTRATION BARRIERS APPROPRIATE.

AIRTIGHT DRYWALL APPROACH -- SOME EXPERTS HAVE ADVOCATED A TECHNIQUE IN WHICH THE DRYWALL IS INSTALLED SO AS TO PROVIDE AN AIRTIGHT SEAL. THIS TECHNIQUE HELPS SOLVE COMPLAINTS OF CONTRACTORS AGAINST THE USE OF CONTINUOUS MEMBRANES OVER THE INTERIOR FACE OF THE WALL STUDS; HOWEVER, VERY LITTLE REAL WORLD RESEARCH HAS BEEN PERFORMED ON ITS EFFECTIVENESS.

INDOOR AIR QUALITY -- WHEN REDUCING AIR LEAKAGE IN HOMES, THE SUPPLY OF FRESH AIR IS REDUCED. POLLUTANTS IN THE INTERIOR AIR, ESPECIALLY RADON GAS AND FORMALDEHYDE, CAN BECOME CONCENTRATED AND THREATEN HEALTH. RESEARCH IS BEING CONDUCTED ON THIS ISSUE ALREADY, BUT AN EXPANDED EFFORT IS CALLED FOR TO REDUCE THE POTENTIAL HEALTH RISK FROM THESE CHEMICALS.

AUTOMATED VENTILATION SYSTEMS -- TO BRING FRESH AIR INTO HOMES, VENTILATION SYSTEMS THAT SENSE INDOOR AIR QUALITY LEVELS AND RESPOND BY BRINGING IN OUTSIDE AIR AND HEATING IT UP WITH EXITING INTERIOR AIR. OF

COURSE, THE OVERALL FIELD OF AUTOMATED HOUSES, OR "SMART HOMES", WARRANTS CONSIDERABLE RESEARCH.

WINDOWS

ENERGY EFFICIENT WINDOWS -- THROUGH PUBLIC AND PRIVATE EFFORTS, A NEAR REVOLUTION HAS OCCURRED IN THE WINDOW INDUSTRY. LOW-EMISSIVITY WINDOWS WHICH HAVE SPECIAL METALLIC COATINGS THAT KEEP RADIANT HEAT FROM LEAVING A HOME IN WINTER, HAVE ENTERED THE MARKETPLACE. CONTINUED RESEARCH ON ENERGY EFFICIENT WINDOWS USING NEW TYPES OF COATINGS, OR SEVERAL LAYERS OF COATINGS, IS UNDERWAY AND COULD USE GOVERNMENT ASSISTANCE TO READY THESE TECHNOLOGIES FOR THE MARKETPLACE.

STORM WINDOWS -- THERE IS CONTROVERSY AMONG STORM WINDOWMANUFACTURERS ABOUT WHETHER INTERIOR STORM WINDOWS OR EXTERIOR STORM WINDOWS SAVE MORE ENERGY. AS INTERIOR STORMS ARE MARKETED MORE HEAVILY AND COST CONSIDERABLY MORE, IT IS IMPORTANT FOR CONSUMERS TO HAVE RESULTS OF OBJECTIVE RESEARCH.

NATURAL COOLING

RADIANT HEAT BARRIERS -- RADIANT BARRIERS ARE CONTINUOUS SHEETS OF REFLECTIVE MATERIAL THAT ARE INSTALLED IN ATTICS TO REFLECT RADIANT HEAT IN SUMMER AND KEEP THE INSULATION COOLER. OTHER GOVERNMENT INSTITUTIONS, PARTICULARLY THE FLORIDA SOLAR ENERGY CENTER AND THE TENNESSEE VALLEY AUTHORITY, HAVE PERFORMED THEIR OWN RESEARCH. I BELIEVE THESE PRODUCTS STAND THE CHANCE OF BEING OVERMARKETED BY SOME COMPANIES. IN FACT, I HAVE ALREADY SEEN OVERPRICED BARRIERS MARKETED AS AN ALTERNATIVE TO ATTIC INSULATION. WE ARE CONCERNED THAT CONSUMERS ARE ALREADY BEING OVERSOLD THIS PRODUCT. OBJECTIVE RESEARCH IS NEEDED TO HELP CONSUMERS MAKE WISE ENERGY CHOICES ON RADIANT HEAT BARRIERS AS WELL

AS OTHER ENERGY PRODUCTS.

DEHUMIDIFICATION -- THE BIGGEST SUMMER ENERGY PROBLEM FOR MANY HOMES IN GEORGIA IS NOT HOT TEMPERATURES, BUT HIGH HUMIDITY. EFFICIENT DEHUMIDIFICATION SYSTEMS HAVE BEEN RESEARCHED TO CAPTURE MOISTURE FROM INTERIOR AIR AND REJECT IT OUTSIDE. HOWEVER, NO SYSTEMS HAVE YET BEEN SUCCESSFULLY MARKETED.

THE ABOVE EXAMPLES SHOW JUST A FEW ISSUES THAT WARRANT RESEARCH SUPPORT FROM THE FEDERAL GOVERNMENT. THE RESEARCH IS NEEDED IN SOME CASES TO HELP CONSUMERS MAKE BETTER DECISIONS ABOUT PRODUCTS, SUCH AS INFILTRATION BARRIERS, RADIANT HEAT BARRIERS, AND STORM WINDOWS. RESEARCH IS ALSO NEEDED TO PROVIDE BUILDERS IMPORTANT INFORMATION ON OPTIONS SUCH AS SLAB INSULATION AND VAPOR BARRIERS. OTHER RESEARCH IS IMPORTANT TO ASSIST DEVELOPMENT OF NEW ENERGY SAVING PRODUCTS.

ARE ANY ENERGY REGULATIONS NEEDED?

STATE ENERGY CODES, WHERE DEVELOPED, ARE GENERALLY ADEQUATE, HOWEVER, THEY ARE POORLY ENFORCED. I HAVE SEEN OR HEARD OF A NUMBER OF NEW HOMES BUILT IN GEORGIA THAT DO NOT MEET THE CODE. IN FACT, GEORGIA POWER COMPANY'S GOOD CENTS PROGRAM DOES NOT REQUIRE THAT HOMES MEET THE STATE ENERGY CODE -- HOMES WITHOUT INSULATED SLAB FLOORS CAN STILL QUALIFY.

IN ADDITION, APPLIANCE LABELING IS IMPORTANT. MANY CONSUMERS WILL SELECT A MORE EFFICIENT PRODUCT IF THEY CAN COMPARISON SHOP. I BELIEVE THE LABELING SUPPORTS THE CONCEPT OF A FREE MARKET SYSTEM. ADAM SMITH'S ORIGINAL NOTION OF A LAISSEZ FAIRE ECONOMY ASSUMED FREE FLOW OF INFORMATION SO ALL PRODUCTS COULD BE COMPARED EQUALLY.

I WOULD SUGGEST DEVELOPING A LABELING SYSTEM FOR HOME HEATING AND

COOLING SYSTEMS. WE RECEIVE HUNDREDS OF QUESTIONS EACH YEAR ON WHAT TYPE OF HEATING AND COOLING SYSTEM IS BEST. A LABELING SYSTEM, WHICH WOULD REQUIRE CONSIDERABLE EFFORT TO DEVELOP, WOULD BE AN IMPORTANT ASSET IN ASSISTING THE CONSUMER AND ENCOURAGING THE USE OF MORE EFFICIENT SYSTEMS.

WHAT INCENTIVE PROGRAMS WOULD YOU SUGGEST?

I BELIEVE THE SOLAR INCOME TAX CREDIT WAS AN IMPORTANT INCENTIVE. UNFORTUNATELY, IT WAS MISUSED BY SOME SOLAR COMPANIES, PARTICULARLY WHEN THEIR SALES PEOPLE COULD USE THE FACT THAT THE CREDIT WAS EXPIRING TO TWIST THE ARMS OF CONSUMERS IN SECURING A SALE. WITHOUT THE CREDIT, THE SOLAR INDUSTRY APPEARS TO HAVE DIED. I FAVOR RESTORING THE CREDIT, BUT IN A REVISED WAY TO PROTECT THE CONSUMER. ONE SUGGESTION IS TO ALLOW THE CREDIT ONLY TO THAT PORTION OF THE SYSTEM THAT PROVIDES HOT WATER AND SET A MAXIMUM PURCHASE PRICE OF $5000. THE REGULATIONS GOVERNING THE CREDIT WOULD SPECIFICALLY STATE THAT NO CASH PAYMENT COULD BE MADE AFTER THE SALE BY THE SOLAR COMPANY TO THE CONSUMER FOR ANY CONSULTING HELP, POTENTIAL CUSTOMERS REFERRED OR ANY OTHER DUBIOUS PURPOSE.

I DO NOT REALLY THINK THE INCOME TAX CREDIT IS NECESSARY FOR ENERGY CONSERVATION.

WHAT OTHER POLICIES DO YOU FAVOR?

I THINK AN IMPORTANT AREA FOR POLICY RESEARCH IS UTILITY FINANCING OF ENERGY CONSERVATION OPTIONS. IN MANY CASES, UTILITY FINANCING OF CONSERVATION MEASURES ON HOMES AND COMMERCIAL BUILDINGS CAN RELIEVE HIGH DEMANDS FOR ELECTRICAL GENERATING CAPACITY AT A SUBSTANTIALLY LOWER COST THAN ADDING NEW CAPACITY WITH CENTRALIZED COAL OR NUCLEAR POWER PLANTS.

I ALSO THINK THE ISSUE OF DECENTRALIZED ELECTRICAL PRODUCTION AND COGENERATION BEARS LOOKING INTO, ESPECIALLY PROVISIONS FOR NON-UTILITY

ELECTRICAL SALES AND UTILITY BUY-BACK OF ELECTRICITY FROM SMALL PRODUCERS. STATES HAVE A MYRIAD OF LAWS THAT EITHER RESTRICT OR ENCOURAGE SMALL POWER PRODUCTION. FOR EXAMPLE, IN GEORGIA, A PRIVATE NON-UTILITY CANNOT SELL STEAM OR ELECTRICITY TO ANOTHER PRIVATE ENTITY.

IN ADDITION, I BELIEVE THE FEDERAL GOVERNMENT SHOULD TAKE THE LEAD IN PURCHASING ENERGY EFFICIENT PRODUCTS. MANY OF THE OPTIONS MENTIONED IN THIS TESTIMONY SHOULD BE REQUIRED. AN OPTION THAT SHOULD BE ENCOURAGED, PARTICULARLY IN THE MANY REMOTE LOCATIONS THAT THE FEDERAL GOVERNMENT HAS FACILITIES, IS PHOTOVOLTAIC ELECTRIC POWER. WE HAVE NOW LOST OUR LEAD IN THE DEVELOPMENT OF PHOTOVOLTAICS TO THE JAPANESE. WE MUST STRIVE TO REMAIN COMPETITIVE IN THIS HIGH TECHNOLOGY FIELD THROUGH CONTINUED RESEARCH, DEVELOPMENT AND PURCHASE PROGRAMS.

WHAT ABOUT FEDERAL GOVERNMENT FUNDING OF STATE ENERGY PROGRAMS?

THE STATE ENERGY OFFICES THROUGHOUT THE COUNTRY PROVIDE VITAL SERVICES TO THE PUBLIC THROUGH SUCH EFFORTS AS WEATHERIZING THE HOMES OF THOSE ON LOW INCOMES, PROVIDING MATCHING GRANTS FOR ENERGY CONSERVATION IMPROVEMENTS TO SCHOOLS AND HOSPITALS, SPONSORING ENERGY AUDITS FOR INDUSTRY, DEVELOPING ENERGY CODES, PUBLISHING ENERGY INFORMATION MATERIALS FOR CONSUMERS, AND CONDUCTING NUMEROUS ENERGY CONSERVATION AND RENEWABLE ENERGY WORKSHOPS, SEMINARS AND DEMONSTRATION PROGRAMS. OVER THE PAST SEVERAL YEARS, MOST OF THE FUNDING FOR THESE PROGRAMS IN MANY STATES, SUCH AS GEORGIA, HAS COME FROM OIL OVERCHARGE MONEY, NOT THE FEDERAL OR STATE GOVERNMENT. A MAJOR QUESTION FOR CONCERN IS WHAT HAPPENS WHEN THE MONEY RUNS OUT. HAVING TO CUT THESE PROGRAMS WOULD INDEED BE A DISSERVICE TO CONSUMERS AND THE ENERGY INDUSTRY IN GEORGIA.

Senator FOWLER. Thank you, Jeff, so very much. I am pleased with your success and your continuing with the institute after Sun Day. When was that, what year?

Mr. TILLER. May 3, 1978. We are approaching an anniversary.

Senator FOWLER. That is great.

Mr. John Mixon, Director of the Georgia Forestry Commission. Welcome, John.

STATEMENT OF JOHN W. MIXON, DIRECTOR, GEORGIA FORESTRY COMMISSION

Mr. MIXON. Than you, Senator, for the opportunity to appear before you today. We have heard a lot of things discussed here today and I will keep in mind that we are restricted to biomass and wood. I am the Director of the Georgia Forestry Commission, I am a forester, I am not an engineer. I cannot speak as intelligently with a lot of these BTU statements and all as some of these other people, but I can tell you about the trees.

Forestry is big business in our state. It is an $8.6 billion industry, providing jobs for better than 80,000 people. Sixty three percent of our state is covered in forest land.

We have a lot of cull type trees out there that if you are going to manage your forests, about half of that 24 million acres is in pine type and about half is in hardwood type. Some people accuse me of trying to convert the whole State of Georgia to a pine state. There is no way that can ever be done. Our oak, hickory is our climax species and if you leave a stand of timber alone for three to four hundred years, it is going to eventually go back to the oak, hickory type.

So as foresters we are continually battling, trying to keep the softwood forest out there. If you cut the softwood forest off, the pine forest off, and do nothing in most of our stands, in three to five years you have got a hardwood forest there, it just converts back that fast with the little hardwood shrubs being on the forest floor.

When you harvest a stand of timber—and we have some operations, we have about 30 total tree harvesting operations going on in the State of Georgia. This is private companies that have bought these large machines that will chip the trees up into wood chips about the size of your thumb. There are about 30 of these in operation in the state, a good many of these are not being able to operate full time because the demand for their product is up and down.

But when you harvest the better products, if you harvest it——

Senator FOWLER. Based on the price of the oil and gas?

Mr. MIXON. Based on the price of oil in most cases.

Senator FOWLER. That is the major factor?

Mr. MIXON. Yes, sir, but again a good many of these are supplying wood chips to the large paper industry and that is kind of up and down at times. In fact, there is a company in Macon, Armstrong Cork, that makes the acoustical tile. They have got two large fluidized bed systems in there and they shut both of those wood systems now down because they have got such a fantastic contract on natural gas. But when that turns around, this operator will go back and in business full force producing the wood.

But as far as when we harvest the better quality and when we harvest the veneer log and the saw logs to pulp, you have got tops, you have got cull trees and other trees there on the forest that wood energy offers them a great opportunity to take that off and use it for energy. If you do not take it off, if it is a pine type forest that you want to put pine trees back in, you have got to pay for someone to come in either with a large piece of equipment to dispose of the culled woods that are out there. Many times this costs a landowner from $100 to $150 per acre to get that site repaired to plant back in the little new pine trees.

The areas that we have got a good wood energy market, I will use as an example, over at Milledgeville, Georgia. Ten years ago, the State of Georgia put money into a wood energy program. We have 11 facilities in the state that have got wood energy systems in. We have got three prisons that are operating on wood, five schools, two hospitals and our central office of the Georgia Forestry Commission there in Macon. A good example is over at Milledgeville, Georgia, we put in a 50,000 pound per hour steam boiler, two boilers, two 25,000 pound per hour steam boilers, and private contractors supply that wood. When we went out on bids for this wood, we had about 12 companies bidding for the state to supply that wood at Central State Hospital, so it has been no problem getting wood supplied at these places we have put the systems in. That system, the State of Georgia appropriated $2.5 million to put in a wood system at Central State. We have been operating now—we had problems getting the thing debugged, but the last three months operation, the State of Georgia is saving right at a million dollars per year using wood over oil and natural gas at that hospital. We are using the wood system to heat the hospital, we are using the steam to heat plus it is being used to air condition the hospital.

So this is just a great example that we have in operation here in the State of Georgia. But the point I would like to be sure and get across, this wood is being supplied by private contractors. This same contractor is supplying wood chips to Georgia Kraft in Macon and some of the other facilities around. But when we went out for bids we had either 11 or 12 of these companies wanting to supply that wood at the hospital. We got it at an outstanding price, the wood is being supplied there, it takes about 8 to 10 tractor loads per day.

We have another system up at Rome at the Northwest Regional Hospital——

Senator **Fowler**. Excuse me, John. Your are confident that all of this wood that is being supplied is cull wood?

Mr. **Mixon**. The bulk of this wood is cull wood. When you are a harvester going out to harvest wood say on 100 acres of forest for the private landowner—another key to this, this energy source is coming off the private landowner's property within a 40 mile radius of Milledgeville, Georgia. In the past, this private landowner has not had an opportunity to sell this material, the company that is cutting this wood has probably got eight or ten people employed in this total tree harvesting operation that is supplying the wood to this facility, so we are talking about a Georgia grown resource, a resource that we really need to move off the land and we are going to come back and put in a new stand of trees. So it is just pluses all the way along.

This one is working quite well. This is proven technology. This is direct fire. This is nothing new, just a new application. This is the type technology that basically all the large wood industries are using here in the state, the Union Camps, the large companies that are generating the bulk of their energy there, they have been doing it for a good while. But we are taking that technology and we are bringing it to a state hospital and it has proven out very effectively over there.

We have another system that is a research and demonstration system. I cannot tell you that the success has been as great with this, but when we put it in we knew it was going to be a research and demonstration and we worked very closely with Georgia Tech on this. Up at Rome at the Northwest Regional Hospital, we put in a wood gasification system. What we did, we took the existing boiler that is there in the boiler room, changed the burners in that boiler. We put the system out 100 foot from the boiler house and we are actually gasifying. What you do, in a large vessel that looks something like a large milk can sitting there that generates a gas, it is piped for 100 feet into this boiler room and it is burned just like natural gas. Now this is research and demonstration. This technology is not proven, there are a number of these being worked on over the country. But I am convinced that we are close and in a few years time we are going to see wood gasification systems that are going to work. And when that occurs, we can retrofit many of the existing boilers that we have got, especially here in the southeast.

Home heating, there are some amazing things happening with home heating. We think of this as being very little, but speaking around over the state, a lot of times I will ask a Rotary Club how many people in there have got some type of wood heat in their home. And I would say in most places 60 to 80 percent of them will have some type wood heat. There are some new systems coming on the market now that you can set the wood furnace outside your house, you can heat your home and your domestic hot water. If you happen to have teenagers in your home, this can be a pretty good savings the way they like to stand under the hot water.

But the point here in the southeast and in Georgia, we——

Senator **Fowler**. They ought to be standing under the cold water. [Laughter.]

Mr. **Mixon**. It does not work that way. I have got teenagers and I can tell you.

But we have got an energy source that we are not utilizing to its fullest potential. We do need more research and development dollars especially in the areas of gasification. I can see co-generation being tied into those wood systems that are coming on line so we have got a tremendous resource here in our state for energy.

We need to move this off the forest if we are going to come back in and put a new stand of trees in those areas, even in hardwood stands. Many of our hardwood stands have been high graded and by taking the poorer quality trees off for wood energy, the new trees that come back from the sprouts are much better than the trees that are there. So from the forest management standpoint, it is a fantastic source of energy that we can utilize that would help us to manage or forests better if we had a better opportunity to utilize it.

And one area we have not talked on is some work that the Energy Department financed several years ago, is wood energy plantations by using University of Georgia and some of the others have done some good work on this. By just planting plantations strictly for wood energy, you can produce tremendous volumes of biomass per acre. But at the present time we have got so many thousands of cords out there that it would help us to have a market for and would help this private landowner to get some revenue from that forest stand if we had market for these.

We have heard a lot about many different systems, Congressman, but this is one when we talk about the plans, biomass and wood in this state could certainly play an important role in what we are doing here.

[The prepared statement of Mr. Mixon follows:]

Testimony
for
Senate Subcommittee on Energy Research and Development
by
John W. Mixon, Director
Georgia Forestry Commission

The Forestry Commission initiated a high priority effort in 1978, nearly ten years ago, to promote wood as an alternative fuel source for both industrial and residential users. Georgia's fossil fuel needs were totally imported at a time that quantities of wood were available from both logging and manufacturing operations.

Additionally, the Commission, through its timber resource inventories, was acutely aware of the vast quantities of standing unmerchantable timber unsuitable for anything except fuel; many trees in the stand components were crooked, diseased, damaged, stunted or otherwise unmerchantable. Since almost nonexistent markets existed prior to 1978 for this type of wood, any usage for energy would benefit the entire state.

The expected benefits to the state of using logging residue and otherwise unmerchantable timber for fuel are:

- The development of a profitable new product for Georgia's timberland owners
- Increased rural employment to produce the product, with virtually all of the profits remaining in the state; and therefore not exported overseas
- Net savings on fuel costs to end users
- Reduced dependence on fossil fuels in the state
- Improved yields from existing forests

The Commission's efforts resulted in the funding of 11 wood-burning units in various state agencies. These units were primarily constructed using Forestry Commission personnel, while two installations were financed by the

Commission and built by contract personnel.

In addition, 24 harvesting demonstrations involving whole-tree chippers were held throughout the state using Commission personnel with state-owned and leased equipment on private lands to indicate availability of wood fuel.

For homeowners, wood heater safety literature has been developed covering all phases of firewood collection, safe and efficient burning, and installation and maintenance procedures.

Further Commisison sponsored activities to promote the use of wood for fuel has been the statewide demonstration of stickwood heaters and whole-house furnaces, and production of video spots (PSA's) to disseminate safety information on industrial and household burning of wood.

Three movie films have been produced by the Commission. One covered the most asked questions on homeowners selection and use of wood-heating appliances. The other two films have been directed at the economics and effectiveness of wood as an industrial fuel. Examples of successful demonstrations, and cost-effectiveness of selected wood-burning facilities at governmental, private sector, and academic institutions were depicted. These are used as technology transfer tools in assisting prospective users of wood energy to assess the merits of various system designs.

The Georgia Forestry Commission, along with cooperation from other agencies, including TVA, Georgia Tech, and Georgia Office of Energy Resources, often sponsor seminars on wood stove stafety and selection, as well as industrial wood systems.

Still, much needs to be accomplished in the way of educating potential users of wood fuel to its advantages in reducing air pollution, its renewability and its widespread availability. While this is particularly true for Georgia with 63 percent of the area in forest land, the entire Southeast has a large supply of wood residues, and logging debris available for fuel usage to substitute for oil, gas, coal and even electricity.

Technology already exists to utilize this wood residue from both forest and manufacturing plants. For instance, whole-tree chipping technology has been developed by a number of private-sector manufacturers. This is a viable means of utilizing heretofore unmarketable cull, diseased, misshapen or otherwise poor quality species. As much as 14 million tons of residue are left each year on Georgia's forest land after conventional logging operations have occurred. This residue is a fire and insect hazard for surrounding timber stands. Additionally, up to $200 per acre is needed to remove this residual before planting the cutover area to new seedlings. Markets, including fuel markets, is the limiting factor for utilizing this material. Additionally, there is an estimated 70 million tons of standing cull and waste trees.

Boilers to utilize this fuel are well developed, meet all applicable emission requirements, and show substantial savings over comparable oil and gas boilers.

Based upon latest available data from researchers at Georgia State University, Georgia households are continuing to rely upon wood as an important source of fuel for space heating. This is true even as natural gas and fuel oil costs have stabilized and there is no longer a perceived energy crisis by many members of the public.

In 1985, firewood consumption was virtually the same as revealed in the 1981 survey, 1.6 million cords. Households using firewood has increased from one in four in 1979 to more than one in three in 1985. An increasing share of households using firewood have come to rely upon wood for more than half of their space heating needs, from 19 percent in 1979 to 38 percent in 1985. The value of firewood consumed by households in 1985 totaled about $125 million, virtually the same as in 1981.

The potential exists for considerable future growth in household firewood use because of installations of new wood-burning equipment, population growth, and recent developments in cleaner burning appliances. A similar survey performed by Georgia State University researchers of industrial wood energy users has shown that the use of wood residues and chips for energy has been highly cost efficient.

By far the largest user of wood for energy in Georgia is the forest products industry itself. In 1984 this industry utilized 5.4 million tons of wood fuel as well as a large quantity of black pulping liquor. The annual fuel cost savings attributable to the substitution of wood residues and chips for conventional fuels by industry, government, and households exceeded $267 million.

In addition to the fuel savings, the substitution of wood energy by Georgia industry, government, and households resulted in an estimated $61.8 million of additional economic activity in Georgia. To produce as much energy as Georgia's wood energy, 13.8 million barrels of fuel oil would have had to have been imported in 1984. For every 2,000 tons of wood chips locally produced in supply of this energy substitution it is estimated that one job is directly or indirectly created in Georgia.

As mentioned, Georgia's potential supply of wood for energy is abundant in relation to current and anticipated demand. The demand for wood energy constitutes no serious competition for the timber requirements of lumber mills, pulp and paper mills, and other forest products manufacturers.

The average delivered prices per ton of residues reported for each class of wood enegy user ranged from $9.63 per ton for the non-wood industry firms to $12.87 per ton for the lumber and wood products firms.

Major reasons given for converting energy requirements from conventional fuels to wood included (1) conventional fuels too expensive; (2) wood supply was readily available at competitive cost; (3) cheaper to burn wood for fuel than to dispose of it; (4) investment in wood burning equipment pays for itself in a few years; and (5) a few respondents wanted to be energy independent.

An example of one successful wood energy demonstration at a governmental facility is the installation at Central State Hospital near Milledgeville, Georgia.

Central State Hospital is operated by the Department of Human Resources and provides patient care in a variety of medical and psychiatric problems. The hospital was established in 1942 and at present contains over 250 buildings with a patient population of 1,850. Many of the buildings have been renovated and converted to prisons and operated by the Department of Corrections. Currently, the population at Central State is approximately 2,400.

In 1982 the Georgia General Assembly allocated $2.5 million to convert the Central State Hospital's heating plant to wood energy. Two of the four existing boilers were replaced with two 25,000 lb/hr wood fired boilers. The system is designed to burn wood fuel and produce steam for heating, cooling, kitchens, laundries, and other processes. The wood system will provide approximately 85 percent of the annual energy requirements. The remaining 15 percent will be provided by natural gas as demand dictates.

Calculations using actual data for January, February and March 1987, showed that fuel cost savings from using wood fuel totaled $298,800 or $99,600 per month. By reducing this savings by the additional labor costs of $31,270 and electrical costs of $20,568 required by the wood system, a net savings for the quarter was $246,960 or $82,320 per month. During this period a total of 12,870 tons or 4,290 tons per month of wood fuel was used to meet the energy requirements of the hospital. Average price of wood for the period was $11 per ton.

Additionally, a new fuel contract has recently been accepted by the hospital at approximately $9.50 per ton. With the summer load for air conditioning, and a lower fuel cost, a greater savings can be anticipated by the end of summer.

There are many successful examples of wood burning systems in Georgia at governmental facilities including public schools, hospitals, and prisons. Economics of such systems points to the need for continued conversion of existing natural gas, oil and electrical based heating and cooling systems that have met or exceeded their life expectancy to new efficient wood systems. Too, wood-fired systems need to be utilized in new facilities presently being designed and built. The Department of Corrections are using wood-energy designs for several of their proposed new prisons. Wood gasification also holds promise as a conversion technology for existing gas boilers in both the public and private sectors.

In order to achieve a greater acceptance and therefore utilization of the available wood fuel supply in Georgia, several areas of opportunities for governmental assistance are evident.

One of these is a continual education process to present the merits of increased wood energy use to design architects and engineers of new industrial plants. There is no better time to install a wood-fired boiler system than when a plant is initially erected. This education need can be met through seminars and continuing education for energy-related professionals.

Also, efforts should be directed to current plant owners and managers who are preparing to replace or rebuild an existing fossil fuel boiler due to wear and obsoleteness. An analysis of current energy demands may show favorable economics accruing from conversion to wood combustion.

Additionally, another important reason for government installation of wood-fired systems in their own facilities, aside from obvious economic advantages is to serve as a local demonstration for successful technology. Local industrial concerns outside the forest products industry can see first hand an operational system.

Other inducements, such as sales tax exemption on wood fuel usage, tax credits for converting to a renewable fuel source, interest subsidies on loans to procure wood fired industrial systems, government sponsored feasibility studies, accelerated depreciation on wood fuel handling components and related buildings and facilities would also serve as incentives to adopt new technology.

An increased use of wood for fuel used in cogeneration is needed for firms to minimize their electrical costs for running production facilities. A tax credit for firms who utilize waste wood instead of fossil fuel for cogeneration would assist in slowing the depletion of non-renewable fossil fuels. A special loan fund for allowing financing of such installations is also needed.

Long-term, as available fossil fuel supplies are depleted or become financially uneconomical to locate and extract, renewable resources such as wood will necessarily take on increased importance in meeting the country's fuel needs. Of course, new markets for cull trees, logging residue and mill waste will tend to have positive effects on the health, growth, and quality of the existing forest, and stimulate local economies.

Senator FOWLER. John, thank you so very much. Let us reserve questions because we will have some time for everybody, so let us have our last witness, and thank you very much for your summary.

Mr. Paul Burks, Director of the Office of Energy Resources for the Governor. Paul, welcome.

STATEMENT OF PAUL BURKS, DIRECTOR, GEORGIA OFFICE OF ENERGY RESOURCES

Mr. BURKS. Thank you, Senator Fowler. What I would like to do is just briefly go through the text that I wrote. I know you are trying to get finished here in the next few minutes.

I would like to make a few statements on behalf of our office and on behalf of Governor Joe Frank Harris. I would first like to begin by stating that we need to take a look at where we have been in energy conservation these last 10–12 years. Everyone has been talking about where we want to go and I will be doing that too, but as a Nation, I think we should all be very proud of the accomplishments that our citizens have made since 1973–1974 in the area of conservation and energy efficiency. Since the time we have focused on the need for conservation, our population has risen by 20 percent but our total energy consumption in this country has not risen at all in that time period. Through the use of efficiency practices, we have drawn enough energy out of 1973 consumption levels to take care of 40 million people in this country. So I think that is a very impressive result for the last 14 years.

But as we know, we still have a lot more to accomplish. Our office is not involved in that much in the area of energy related research like many of the other people who have spoken to you today, But we are a link in what is terms as technology transfer, or more simply stated, taking energy research knowledge gained in the laboratory and putting it to work to save energy or use it more efficiently in homes, factories, farms and offices.

Of the programs funded by our office, two particularly point out the importance of continued and enhanced funding of Federal efforts in energy conservation and research. Since 1971, we have funded a program for Georgia Tech called Industrial Energy Extension Service and since 1980 we have funded a program at the University of Georgia's College of Agriculture Cooperative Extension Service called our Energy Utilization in Agriculture program.

Through the Industrial program, in the last three years along, Georgia Tech estimates that their in-plant technical assistance coupled with continuing education, energy education that they do, that saved Georgia's industries, on an annual basis, $151 million and achieved annual energy savings of 29 trillion BTU. These are annual savings and these become cumulative savings because these energy measures, these energy conservation opportunities are continued year after year.

The larger and more complicated the manufacturing process, the greater the savings become and the more relevant the research that has gone on is to those savings. For example, a north Georgia food processing plant which employs over 400 persons, must maintain strict humidity and temperature levels in their production areas. An energy audit conducted by Georgia Tech revealed that considerable savings could be obtained through diversion of the company's old energy inefficient air handling system and through the installation of an energy management system to cut down on their electrical peak demand. The plant took this advice from Georgia Tech and implemented these systems and they have reduced their annual energy cost by $160,000 and were able to improve the plant's environmental system.

Under our agricultural program at the University of Georgia, funding originally was made available to do energy audits, energy tune-ups, of irrigation systems. And that program has now gone on to be involved on poultry houses and greenhouses. In the area of irrigation systems, Georgia has over a million acres of irrigation and 11,000 pumps all over the state. Of course, that requires millions of gallons of diesel fuel. Through the energy technical assistance program that has been going on, we have seen dollar savings of $650 per system per year.

As I mentioned, this program has gone from that and is now involved in other agricultural facilities, but increasingly the audit recommendations are passing the stage of simple system tune-ups and greenhouse window repair and entering areas requiring more detailed engineering and scientific investigation. We have some new agricultural programs at the University of Georgia that they are now getting involved in that are stemming from this technical research and development. These include such things as reduction in lighting levels and egg production facilities, sophisticated lighting techniques, elimination of air temperature stratification in poultry houses and a new program is the recovery of waste heat from cotton ginning equipment.

The same is true in our industrial program. Most of the easy industrial energy has already been saved or at least the knowledge is there to save those, and these enterprises are increasingly looking toward, turning to higher technology developed from energy research. Energy conservation recommendations commonly made today did not even exist or were not cost-effective even five years ago. Examples of these measures are electronic ballasts for fluorescent lamps, lighting fixture reflectors, high-efficiency motors, advanced facility improvements and advanced controls for boilers and heating and ventilation and air conditioning systems.

Well for tomorrow in this country, I think that a lot of Americans and a lot of Georgians specifically are looking at the area of renewables and alternatives to solve some of the problems that they see coming by the end of this century or in the next century. But the citizens will not turn to renewables and alternatives except in those areas where they see these technologies being reliable, long-lasting, capable of largely displacing their existing conventional requirements in the residential setting, and within a reasonable cost range. But I think these things are well within the realm of reality in the work that can be done over the next decade through enhanced energy research and development, which is the idea of your legislation.

I thank you for those comments. I hope I did not go too fast.

I do have a letter from Mr. Ken Nemith, and he is Executive Director of the Southern States Energy Board. In the interest of time I will not read that letter but I would like to make that available.

Senator Fowler. Absolutely, it will be part of the record, as well as your full statement, Mr. Burks.

Mr. Burks. Thank you.

[The prepared statement of Mr. Burks follows:]

TESTIMONY OF PAUL BURKS, DIRECTOR, GEORGIA OFFICE OF ENERGY RESOURCES, BEFORE THE RESEARCH AND DEVELOPMENT SUBCOMMITTEE OF THE SENATE COMMITTEE ON ENERGY AND NATURAL RESOURCES
JULY 13, 1987
ATLANTA, GEORGIA

Mr. Chairman, members of the Energy Research and Development Subcommittee of the Senate Committee on Energy and Natural Resources, my name is Paul Burks, and I am the Director of the Georgia Governor's Office of Energy Resources, the State of Georgia's primary energy agency. On behalf of Governor Joe Frank Harris, I am pleased to present testimony to this Subcommittee on the importance of continued and strengthened federal energy research and development efforts.

The Georgia Office of Energy Resources was created by the Georgia General Assembly in 1976, and operates as a separate state agency, with a mission of administering programs that lead to the conservation of energy and the promotion and greater use of renewable and alternative energy resources. As Americans we should all be proud of the accomplishments that our citizens have made in the area of energy efficiency since we first realized and focused on the need for conservation in 1973. Since that time the population of our nation has risen by 20% with no rise in our total energy consumption. Literally, through the use of energy conservation and greater efficiency practices, we have been able to wring out enough energy from our 1973 consumption levels to meet the needs of an additional 40 million people.

But, we know that while we have accomplished much, we still have much more to accomplish. While our Office does not conduct energy-related research, we are a link in what is termed as "technology transfer" or more simply stated--taking energy research knowledge gained in the laboratory and putting it to work to save energy or use it more efficiently in the home, the factory, the farm, or the office.

Of the programs funded by our Office, two particularly point out the importance of continued and enhanced funding of federal efforts in energy conservation and alternative energy research and development. Since 1977 we have funded the state's Industrial Energy Extension Service through the Georgia Tech Research Institute and since 1980 we have funded an Energy Utilization in Agriculture program through the University of Georgia's College of Agriculture, Cooperative Extension Service.

Through the Industrial program, in the last three years alone, Georgia Tech estimates that their in-plant technical assistance coupled with continuing energy education has saved Georgia's industries, on an annual basis, $151 million and achieved annual energy savings of 29 trillion Btu. These are annual saving that become cumulative savings, showing the multiplier effect of these programs. And the larger and more complicated the manufacturing process the greater the savings from advanced technologies.

For example, a north Georgia food processing plant employing over 400 persons, must maintain strict humidity and temperature levels in its production area. An energy audit conducted by this program revealed that considerable savings could be obtained through conversion of the company's old, energy inefficient air handling system to a variable air volume system through the installation of variable speed motors. An energy management system was also recommended to reduce the plant's electrical demand. The plant has implemented the conversion recommendation and has installed a state of the art building control system. In addition to the traditional energy management functions of load shedding and duty cycling, this system also provides improved control of the plant environment and has reduced annual energy costs by $160,000.

Under our Energy Utilization in Agriculture Program, conducted by the University of Georgia, funding has been made available to provide energy technical assistance to those involved in Georgia agriculture. Energy programs have been conducted for a variety of agricultural endeavors, including irrigation systems, poultry houses, and greenhouses. In the area of irrigation systems, with over 1.1 million acres of irrigation in the State requiring some 11,000 pumps, millions of gallons of diesel fuel are required to provide water for Georgia crops. Through this energy technical assistance program, dollar savings of $650 per system per year have been documented.

With encouraging results such as these, the program has expanded over the last several years to include energy audits and recommendations in greenhouses, poultry houses and livestock facilities. Increasingly, as in the industrial program, the audit recommendations are passing the stage of simple system tune-ups and greenhouse window repair and entering areas requiring detailed engineering and scientific investigation and data development that require significant research and study prior to implementation. Examples of new agricultural programs that we are planning which stem from technical research and development include reduction in lighting levels in egg production facilities through sophisticated lighting techniques, elimination of air temperature stratification in poultry houses thereby reducing electrical costs, and the recovery of waste heat from cotton ginning equipment.

These examples, while illustrating the successful implementation of various energy conservation measures actually shows the degree to which research and development has paid off in energy conservation practices. Most of the "easy" industrial and agricultural energy has already been saved and these enterprises are increasingly turning to higher technology developed from energy research. Energy conservation recommendations commonly made today did not even exist or were not cost-effective five years ago. Examples of these include electronic ballasts for fluorescent lamps, lighting fixture reflectors, high-efficiency motors advanced facility envelope improvements, and advanced controls for boilers, and heating, ventilation, and air conditioning systems.

And what will we need tomorrow? Tomorrow, American industry and the public will need those renewable and alternative energy resources which, today, should be under full review and experimentation by our federal laboratories. Through our informational and educational programs we see a public eager to enjoy the benefits of renewable energy technologies. But, they want those technologies to be reliable, long-lasting, capable of largely displacing existing conventional requirements, at least in the residential setting and within a reasonable cost range. This is certainly well within the realm of reality, but only if renewable research efforts can continue with the full support of an active and sincerely committed federal administration. We need these federal efforts for the development, evaluation, education, and implementation of solar and renewable technologies or valuable energy conserving measures and their related technical advice and assistance will not come to fruition. Thank you.

Senator **Fowler**. Thank you very, very much.

I want to get everybody together here but I guess—I am not trying to stir up any controversy, but there was some testimony questioning the enforcement of state building codes concerning energy. Would you like—I will not prejudice you one way or another—would you like to tell us what is being done and whether or not resources are adequate to enforce the codes for energy conservation at the state level.

Mr. **Burks**. I will be glad to. Jeff and I are old friends and we talk about this a lot. The state does have an energy code that was passed in the late seventies. The state energy code is the responsibility of the State Department of Community Affairs. However, this code, while it is a mandatory code, it is up to local governments to enforce the code. I guess it is a home rule type issue. So therefore, if local governments do not have the manpower, person power, to go out and enforce the code, the code does not get enforced.

You see the code most enforced of course in those counties, those areas where there is more population, therefore more tax revenues to support these types of activities; Atlanta, Savannah, Macon, Columbus, et cetera.

Senator **Fowler**. Are there any state funds appropriated directly to local governments to help them?

Mr. **Burks**. I do not know if they do in the total codes area. One thing we are doing with funds that we have, oil overcharge funds, we are making funds available now to the Department of Community Affairs for additional energy code training, education, activities. We have been doing that through the University of Georgia for the last several years. We have a person that we fund through that Department that goes out and travels the state to teach the energy code to the local officials. We are trying to put more money into that as far as actually having more people who would be on the road in the state, teaching people about the energy code. But what Jeff is saying is true, I do not dispute that, there is not enough adherence to the code, especially in those areas of the state where they just do not have the code officials to do a variety of things beyond energy codes.

I do not know if that is really a Federal activity, it is probably not.

Senator **Fowler**. Sure. Mr. Grundy has a question.

Mr. **Grundy**. You mentioned the oil overcharge money that you are getting, do you feel that you have sufficient flexibility in the use of that money that you can direct it where the greatest need is?

Mr. **Burks**. We do in our state, I do not know about—I cannot speak for other states. But in our state we have been—the last two years especially when we received the Exxon oil overcharge funds and the Stripper Well funds, a lot of those funds have been used, a high percentage have been used to assist low-income persons, that is our first priority in the area of helping them pay their bills and weatherization of their houses. And then once we get beyond that, of course, the rest of it is going into energy conservation. All the rest of the funds—we are not putting it into road building as some other states might do, or things like that. We are putting it in energy conservation activities.

We have our plans already approved and are in the activity right now for spending those dollars in the state. If you would like to see what we are doing, I would be glad to provide you that. We have got 50 programs where the oil overcharge money is going in the state to do energy conservation projects. If you are interested in that, I will be glad to supply it to you.

Senator FOWLER. Dr. O'Neil, why do you not come on up here and join Paul, Dwight and the other three—everybody, take a seat here on the front row.

Does any one on the panel want to make a quick comment in rebuttal or is left out or anything you heard that you would like to comment on for the good of the order?

Go ahead, Jeff Tiller.

Mr. TILLER. One area not mentioned and you have been very supportive of is income tax credits for solar types of activities.

Senator FOWLER. Well I think those have gone now.

Mr. TILLER. They are gone definitely. I have a proposal in my testimony that would be for a lower scale effort and I am not sure if that is possible to work out or not, but I did want to bring that out.

Senator FOWLER. Good. Well we——

Mr. TILLER. It is mainly the collector industry is doing the quick dive and it is a viable industry, it is just really rising right now, so there is a proposal to do something.

Senator FOWLER. Well, I will take a close look at that. We fought the good fight there, but I am just attesting to the political realities. I do not think we will see any credits this year or next year. We will have a new administration—this is not a partisan statement—it is a statement of a Constitutional fact that on January 1, 1989, we will have a new President and a new administration that hopefully will take a "re-look" at the whole energy area that we have been discussing this morning as well as its import for energy security and national security of the country.

In fact, I started to interrupt you, but in your mentioning of the Persian Gulf, as everybody in this room knows, but we might as well say it publicly, the U.S. Stark and other very difficult decisions that we are going to have to make concerning our military deployment, would not be made if we were not dependent, as we are, on that oil from the Middle East. And so much of the money that we will spend, and possibly lives that we will spend, on behalf of our country in quote "guarding" the Persian Gulf and keeping the sea lanes open, would not be necessary if we did not have the growing dependency on foreign oil imports that we see and that all of you, especially you, Dr. O'Neil, testified to this morning.

So this question of alternative energy strategies and attempts to develop a comprehensive energy policy for our country have far more dimensions than simply the application of new technology to our residential and commercial buildings, as important as that is, and I appreciate all of you incorporating that broader view into your testimony.

Did you want to say something, Dr. O'Neil?

Dr. O'NEIL. Quickly one thing that I overlooked but you did mention, Senator, was the whole concept of advanced solar manufacturing technology of strategic materials. That is the use of solar energy to produce materials which are of a strategic nature to the country and in the written testimony we have outlined very concisely a methodology where we think that we can essentially leverage the Department of Energy funds and get additional financial muscle from the broader industrial community to support the new solar thermal technology companies, the smaller ones in particular, by essentially using solar energy to produce advanced carbon materials, new metals, new ceramics and so on in a way that cannot be done by conventional processes. It would be a unique set of products produced by essentially a unique process, that is solar processing.

Stealing our thunder right now are USSR initiatives in this whole area, but I think it is probably deserving of some oversight by your staffs and by your Committee to consider the possibility of Department of Energy perhaps being the lead agency in this whole area, whereby DOD, the NASA and other subagencies of those organizations get involved with the whole development of solar thermal technology with the bulk of their finances.

Senator FOWLER. Very good suggestion. Frances?

Ms. ZWENIG. Mr. Ellingson, I wonder if you would comment on the potential—and the rest of the panel as well—the potential of energy conservation as opposed to the potential for alternative energy technologies.

Senator FOWLER. Given the economies of scale that we always hear that a dollar spent on conservation will save two or three dollars.

Mr. ELLINGSON. Well there are savings from conservation available and many of those savings have already been achieved, at least those that are feasible for retrofits on residential homes. We do—every two years we do a survey of our customers on conservation activities that they put on or plan to undergo and specific questions about just what they have done. Higher levels of insulation, window glazing with storm windows, both floor and ceiling insulation seem to be the most common activities and since the oil embargo and energy price escalations that went on through the seventies, there was quite a bit of it. Our good cents home program was mentioned, we encourage all builders to build according to our good cents standards which require high levels of insulation. We see significant savings in our generation needs if someone does use a good cents home. And we think there are savings there and they are beneficial and have quick payoffs.

Ms. ZWENIG. But can you project into the future, what potential there still is? People make the case that the savings that was made in the last ten years has been wholly attributable to energy conservation. Is there still as much potential in the next ten years as we have realized in the last ten years?

Mr. ELLINGSON. In the sense of new housing, yes although the new housing development itself is going to slow down because of the distribution of population. Existing homes, there are still some homes that have not been retrofitted, but again, those numbers are declining with time. The benefits are there, I think the market sees them, homeowners see them as beneficial or not beneficial in terms of savings on their energy bills.

Ms. **Zwenig**. Would you all like to comment?

Dr. **O'Neil**. I think I might be able to help out here, using some International Energy Agency figures. Let me say in 1984 we had reduced our total consumption of oil from .72 tons of oil equivalent per $1000 GDP from 1.14 value. In other words, we have reduced at 25 percent through 1984. The potential for further diminishment is from .90 down to .7 or .72, which is another 20 or 25 percent. I do not think those are the easy BTUs to get out, hence the need for conservation research and development initiatives and the necessity to sustain that. I think we as a Nation ought to look at conservation as a credit, as a barrel of oil. Every time you save that equivalent in energy, that is a barrel of oil we do not have to buy into this country. So I classify it, differentiate it from alternatives, as part and parcel of the total energy picture of renewables making a contribution.

Mr. **Burks**. Yes, I was going to say we have just begun in the area of conservation. The savings available out there, I will not say they are limitless but they are certainly far beyond what we have done already. Just take the area where we weatherize homes of low-income persons, all around the country we have barely scratched the surface, maybe hit 10 percent of the homes. In the homes we are doing now we are saving 25 percent per home that we do in Georgia and this is on very basic items that we are talking about in these houses. This can be expanded to any type residential, industrial commercial—there is so much more to be done. Going back to the value of the research we talked about here is this sort of pump, it gets the water going that you might say eventually goes down and that becomes the information that we have later on to put into homes or businesses or industries. So it is valuable that that continue because they are discovering all sorts of things in these laboratories.

Mr. **Ellingson**. If I could just expand on this a little bit. Most of the oil savings that occurred since the mid-seventies occurred because of reduced automobile size and changes in trucking and railroads use of oil.

If you look at homes themselves, I think you will find that the average use in a household is actually going down, at least as far as electricity is concerned, substantially. We are now down to about 800 kilowatt hours per month per house. Ten years ago we were at 1000 kilowatt hours. A lot of that is due just to the number of people that live in a house. If you look at electricity consumption per person it has actually gone up rather than down, so that the households have grown much faster than the population has and that is why you see consumption dropping in the household, but per capita consumption at least for domestic uses of electricity has actually gone up. It is something we are going to have to face for another 15 or 20 years.

Dr. **O'Neil**. One final point here. The Association of Energy Engineers is based in Atlanta and their recent figures indicate that 89 percent of all buildings have not yet been audited in the country and of commercial buildings 97 percent do not have microprocessor controlled energy management systems. And that is a real tragedy. So the potential is there I think.

Mr. JONES. We have seen that energy conservation in existing buildings can save significant energy and as part of the Office of Energy Resources funding through the Exxon and Stripper Well we have been able to save at Central State Hospital that was talked about earlier and the Northwest Regional, $150,000 a year just in energy conservation projects.

Senator FOWLER. Is that the money that comes off the leased Federal lands?

Mr. JONES. No, sir.

Mr. BURKS. No, sir, that is the money that the oil companies allegedly overcharged the public in 1970's. The courts and the Department of Energy through many years or arduous work have determined that a lot of those funds needed to go back through state governments to provide restitution to citizens, they are being used for primarily energy conservation projects and energy systems.

In the State of Georgia right now we have some $70 million in our office's account to be used for those purposes. Nationally it is probably in the area—well nationally it is about $3 billion out there in the states.

Senator FOWLER. Well that is not an insignificant amount.

Mr. BURKS. Not at all, not when our budget is only about $6 million a year and it goes to $70 million in one year. But these are short term things.

Senator FOWLER. Have you a document that tells how you are going to use that money?

Mr. BURKS. Yes, sir, we sure do. I did not bring it with me but I will be glad to give it to you.

Senator FOWLER. I would like very much to see it.

Mr. BURKS. In fact, I think I have given that to Frances when I came up in May, I did provide you with our plans.

Senator FOWLER. Well that is better than giving it to me, but I would like to see it.

Cheryl?

Ms. MOSS. I wanted to ask a little bit, we have been talking a lot about research and development and how we can best leverage Federal dollars in that area. In fact, I believe in Mr. Ellingson's statement he said something about getting the best return for our money by concentrating it on research and development. I was wondering about the role of demonstration. What is the adequate time frame for demonstration projects, what purpose do they serve, and what is the best Federal role to play in that area, or is that something that is best handled at the state and local level?

Mr. ELLINGSON. There is a role for the Federal government to play in demonstrations, they have. The STEP project at Georgia Power Company is a demonstration project that was financed by DOE money. There are a couple of problems with demonstration. First of all, you do not need real large scale demonstrations to get the benefits of the scale of technologies. We have learned a lot from the STEP I think about how to put things together and how not to put them together and where the problems exist in the field, with relatively small scale projects. So demonstrations can be accomplished and a lot of things learned without enormous size projects. Secondly, it is a judgment call really. If you have got technologies that look like they belong in the commercial sector and they have a high chance of success, or at least a reasonable chance of success, then you do demonstration projects on it. There are some things that will be developed that are currently under way, that if their funding continues will appear in the 1990 to 1993 time frame. And that is the time to start thinking about scaling up. That would still give us, if nothing goes wrong, two or three years before we will start to see oil prices escalate again—for demonstration projects.

Mr. MIXON. I would like to comment on that. In wood gasification, this is an area that private industry has put a good bit of money in over the past few years. I think it is technology that is real close to really being developed where we can count on it, but many times the Federal Government tying in with states and with industry to help fund some of these demonstration projects, and I think you need a project that is large enough that people can come see that is really working. You know many times, it can be too small. Especially with something like wood, if you have got a system that you can show people is working and have some good numbers to tell them what you are doing with that system, you can convince other people. I know there are many industries here in our state today that has looked into wood gasification and they are considering it. In fact we need a good system somewhere that is working to show them.

Mr. BURKS. On demonstration projects, we like them very much and we just had a program the last two years in the area of renewable energy where we provided a grant program for local governments of Georgia to receive—actually they did not receive money, they received the actual equipment and installation, Jeff Tiller's organization worked for us in that project, and 25 communities in the state have now received small scale solar projects to be actually working in their communities, working in the fire station, working in the city hall, working somewhere in the community, or a school, where the people there can go and see the results of renewable technologies. One of them just recently dedicated was in Statesboro, Georgia at the Science Museum there and they used photovoltaics there to do some lights and fans. It is very well shown to the public what it is. They receive some 30,000 school kids every year that go there to see the dinosaur bones and things like that in the museum. So we look at that as really a way to make the public more aware of the potential of these technologies.

So those kinds of demonstrations I think are very effective.

Mr. TILLER. You might mention, Paul, that of the how many applications you received, just because of the interest in that.

Mr. BURKS. That is right. The first time around, we had 15 grants and we received 45 applications from local governments throughout the state. So local governments—these are communities of all sizes and we are talking a lot of very small communities in some cases, were very interested, very interested in receiving some of these renewable technologies to show off in their communities.

Dr. O'NEIL. If I could just comment and try to do it quickly. I think one has to grasp the idea that this concept of innovation pipeline and where R&D falls and where commercial demonstrations fall. We have got to accelerate obviously the development of our technologies so they come out the backend. R&D has been indeed the focus. The further out you go as the technology begins to prove itself, of course the risk declines, but inversely to the increasing cost of demonstrating that or making it full proof so to speak. That is where I think there is a technology demonstration phase which is generally lower cost. For instance, we have built 25 ton per day wood to liquid fuels plants at Georgia Tech and in the million dollar region which is a pretty modest thing. It excites the businessman who comes in and sees a large scale thing. It allows our engineers to work with our scientists to get some real life engineering data, but the next time that sets up to a 100 ton or 1000 ton, that is when you will have, through the technology demonstration attracted in the commercial matching money that we need, either that or some state supporting money if it happens to be something that a state is likely to benefit from.

So they are important but they are very costly and I heartily recommend that cost sharing cooperative ventures, matching monies be considered when we put funds into the demonstration category.

Senator **Fowler**. I always like to just take a couple of minutes, anybody in the room, anybody from the public that would like to offer any quick suggestions or follow up with a question to any of our panel. Yes, sir, state your name please.

Mr. **Spauschus**. My name is Hans Spauschus, I am the Director of the Energy Material Sciences Laboratory at Georgia Tech. I think the quality of the presentations speak for themselves in terms of the interest and importance of this subject. I have one question more for a point of clarification than anything else, directed I think at perhaps Mr. Jones, Mr. Tiller or Mr. Burks. In the discussion relative to energy conservation in buildings and how one promulgates an improved energy savings program across the board, there was very little mention—I think no mention or the role of associations such as the American Society of Refrigeration and Air Conditioning, who has been working I know many years in developing I think what they call standard ID which is a proposed standard not in terms of setting regulatory numbers but in terms of developing a methodology and I wondered what comments the witnesses might have relative to this kind of a contribution to what we are trying to accomplish.

Senator **Fowler**. Any takers? Mr. Jones?

Mr. **Jones**. I can speak for the American Society of Refrigeration and Air Conditioning Engineers, as a member and as a participant in writing the 9.1 standard which is energy conservation in buildings. There were basically two factions, one in the engineering community and one in the architectural community relative to how that should be promulgated in our design community. I have been in favor of the performance approach as opposed to the prescriptive approach and ASHRE has seen that the prescriptive approach may not be the best way to promote energy conservation in buildings. Because of lack of building the Building Energy Performance program has sort of subsidized and the ASHRE committee has continued, so there is still work being done in energy conservation in buildings, and ASHRE takes into account all systems in a building; glazing, mechanical, electrical and all the systems. So I think it is a good opportunity that whatever performance criteria is developed, that the 90.1 program should be a part of it.

Senator FOWLER. Thank you. Anybody else? Yes, ma'am?

Ms. NELSON. My name is Jane Nelson, I had a question regarding conservation. It seems that most of the discussion on conservation centers upon thermal savings due to trying to regulate heat or air conditioning in houses or buildings and I wondered about like new lighting technologies that are available to also increase savings. I wondered about the estimate of those in dollars savings.

Senator FOWLER. Anybody? Dr. O'Neil: I will take a real quick stab and my only comment is this, I think the budget for the buildings program, buildings research and development program within DOE is something in the order of $4-6 million, I think the representation this year is for $4 million. That includes both active and passive devices. I think they fund about three programs including something dealing with electro-chromic windows and other devices to get daylight out from the external regions of the building and funnel it in by suitable technology into the interior portions. As far as I understand that is an industrial thing, I think Honeywell was involved. But basically the innovations are few and far between. Somebody else might——

Mr. BURKS. I could just add to that. A great thing about lighting reductions and you can get it especially in commercial and industrial setting, is that you save energy three times. You reduce the light level, that saves energy; you reduce the heat in the building, that reduces the air conditioning cost; and you also reduce on the demand, the peak demand because lights increase the load, they are running all day long. So doing efforts in the area of lighting reduction would be a terrific thing because you save three ways.

There have been a lot of—I think the lighting industry in many ways has been a real leader these past ten or 12 years. They have done quite a bit of getting efficiency out of their lamps, but daylighting and some of those things probably could use a lot more work.

Mr. ELLINGSON. As far as competitive advantage goes, Europeans are way, way ahead of us on lighting.

Senator FOWLER. In sophisticated lighting technology.

Mr. ELLINGSON. That is right. We have some lights that we have been looking at that are 18 watt bulbs that yield 60 watts—equivalent light to a 60 watt lightbulb, and in many cases they are feasible to use.

Mr. JONES. There is a large qualitative problem that needs to be overcome in lighting in that the American people have been used to 100–150 foot candle light on their work surfaces. What we have been able to provide, and actually there was a demonstration in this building of high pressure sodium lighting that did not prove out to be successful because of some other problems other than quality of light. We can actually deal better with the 40–45 foot candle level on our work surfaces and do not need 150 foot candles for work surfaces, depending on the process. If you are an engineering draftsman, you need more than 40 foot candle, but you probably on your desk maybe only need a 50 foot candle and that is adequate. So there is also a qualitative value that has to be there and that is what we will accept.

Senator FOWLER. Well ladies and gentlemen, I am personally and deeply appreciative to all of you for taking—giving us, us meaning the representatives of the people and our staffs, all of your morning. I, speaking personally which I guess I am allowed to do in my own state, I did fight to win a seat on the Energy Committee because of my interest in this area. I would like to send all of you, if you have not all gotten it, my proposed legislation.

And I earnestly solicit your continued input and suggestions over the next two or three or four years as we try to come up with other initiatives that will comprise a national energy policy and not continue to coast along relying on cheap oil prices.

One of these days all of a sudden a crisis will be upon us, so I hope that we have as long, Ernest, as you hope also.

Mr. ELLINGSON. I hope so too.

Senator FOWLER. But you never know—it could happen next week in this very volatile world of ours. So I am pleased that the Chairman of the Energy Committee in the Senate, Bennett Johnston of Louisiana, as well as my Chairman on the Energy Research and Development Subcommittee have not only allowed these kind of hearings to take place around the country but also both expressed more interest in the need for us to do some real work and see where we are going as a Nation.

Let us just stay in touch as we try together to develop a policy. Thank you all very much for coming. We stand adjourned.

[Whereupon, at 11:45 a.m. the hearing was adjourned.]

APPENDIX

ADDITIONAL MATERIAL SUBMITTED FOR THE RECORD

SOUTHERN STATES ENERGY BOARD
2300 Peachford Road, Suite 1230
Atlanta, Georgia 30338
(404) 455-8841

July 9, 1987

The Honorable Wyche Fowler
United States Senator, Georgia
320 Hart Senate Office Building
Washington, D.C. 20510

My dear Senator:

On behalf of Governor Gerald L. Baliles of Virginia, chairman of the Southern States Energy Board, let me commend you for your efforts to develop legislation promoting conservation, alternative energy sources and renewable resources. Federal support for continued research and development in these areas is vital to the energy future of the United States.

Imports of crude oil and refined products are growing at an alarming rate. In the decade since the enactment of the National Energy Act imports have risen to a level greater than the level that existed at the time of the Arab oil embargo. Moreover, the U.S. and our allies depend upon imports from a highly volatile and unstable part of the world. The controversy surrounding the U.S. role in the Persian Gulf should serve as a warning that our energy situation is no more secure now than in 1973.

For many years, government fascination with atomic power precluded funding of research and development for other energy sources. Not until Oyster Creek 1, which went into commercial operation in 1969, was a nuclear power plant built without government subsidies. The first meaningful federal budget commitment to energy research in other areas was not made until the "Project Independence" budgets of the mid-1970s.

The recent apparent breakthroughs in superconducting materials and techniques has clearly demonstrated that research and development can produce a technology capable of totally altering our energy picture. The slow but steady progress made in wind energy, photovoltaics and other renewable and alternative energy resources also holds promise for the future. Gains in conservation and cogeneration introduce greater efficiency in the electric utility industry and help delay or eliminate the need for expensive generating capacity.

Members: Alabama, Arkansas, Florida, Georgia, Kentucky, Louisiana, Maryland, Mississippi, Missouri, North Carolina, Oklahoma, Puerto Rico, South Carolina, Tennessee, Texas, Virginia, West Virginia

Research and development should, in my opinion, be a partnership between industry, government and the academic community. The proposal to organize the national laboratories into centers of excellence for advanced research and development would be a step in the right direction. Science and technology are critical influences on the security and well-being of the nation and U.S. leadership in science and technology is being challenged aggressively by several other nations.

Adequate, reliable and affordable supplies of energy are key to the future economic vitality of the South and the nation. Moreover, the development of domestic renewable energy resources would reduce the level at which we import energy and export jobs and money. Your efforts, and those of your colleagues, to attain the ultimate goal of energy security are laudable and timely.

I have asked Mr. Paul Burks, one of Georgia's representatives to the Southern States Energy Board, to present this letter at the public hearing you have scheduled for July 13, 1987 in Atlanta and would ask that you make it a part of the record of that hearing.

Sincerely,

Kenneth J. Nemeth
Executive Director

KJN:ajw

M. JANE NELSON TESTIMONY TO 7/13/87 SENATE SUBCOMMITTEE HEARING ON RENEWABLE RESOURCE INDUSTRY

My name is Martha Jane Nelson. I currently reside at 485 Spalding Drive in Atlanta, Georgia 30328. My phone number is (404) 668-9451.

I received a Bachelor's degree in Engineering of Economic Systems, specializing in Technology Assessment and Forecasting, from the Georgia Institute of Technology located in Atlanta, Georgia, in 1976. I received a Master's degree in Business Administration, specializing in High Technology, from Northeastern University located in Boston, Massachusetts, in 1986.

Since 1976 I have worked in the energy industry. For seven and one-half years I was employed by the General Electric Company in various departments which were engaged in the engineering, manufacturing, sales and service of equipment for the power industry worldwide. For almost two years I was employed by the Municipal Electric Authority of Georgia, a joint action agency engaged in the purchase and sale of bulk electric power on behalf of approximately 50 cities and/or counties in the state of Georgia. My primary responsibilities while employed by both of those entities involved analysis of options for technology used to generate electrical power and long-term planning for purchases (or sales) of power generation equipment. For the last two years I have been self-employed part-time as a consultant in order to support myself during the start-up phase of a corporation which I founded in

1986. The corporation, Applied Cooperative Technology Systems, Inc., is a project engineering firm whose primary purpose is to provide renewable resource based power systems for stand-alone or grid-connected applications worldwide.

The testimony I am about to give is my professional opinion based upon my education and eleven years of experience in the energy industry. It does not necessarily reflect the views of my former employers, although the information I have is, in many cases, available to me as a direct result of my association with them.

My objectives in giving testimony to the Subcommittee are: to identify some key issues affecting the growth of the renewable resource industry; to examine the roles and interests of the major participants in the market; and to propose specific actions appropriate to the scope of the U.S. Senate which would facilitate the growth of a healthy renewable resource industry.

Several technologies categorized as renewable resource technologies have reached a sufficiently mature point in product development to be considered technically feasible as reliable sources of (electrical and/or mechanical) power generation. These include solar thermal, photovoltaic, wind, hydro, biomass, and waste technologies. While all of these technologies are in use in many places in the world, certain factors have affected the perceived economic viability of some of these technologies. These factors have acted as forces which slowed the widespread acceptance of the technologies, and as such have hampered the growth of the renewable resource industry. It is specifically the factors relating to the perceived economic viability of renewable resource technologies which I am calling key issues and which I intend to address here.

In identifying the key issues involved in the slow growth of the renewable resource industry, it is helpful first to recall the reasons which make the use of renewable resource technology desirable. A major premise is that it is in the best interest of society in the long run to preserve nonrenewable resources for future use. Such resources as coal, oil, gas and uranium exist in a finite supply which may be exhausted at some undetermined future time. Furthermore, these resources, which are found in their natural state below the surface of the earth, are becoming more difficult (and thus more expensive) to obtain as we use up the supplies near the surface and must go deeper to find more of them. Renewable resources, by contrast, are available in large (practically infinite) supply now and in the future. Consequently, by utilizing renewable resources to provide power, the supply of nonrenewable resources may be extended for the future.

This characteristic of renewable resource technnology, i.e., the ability to provide power while preserving society's finite fuel resources for future use, is one reason that utilization of renewable resource technology is considered desirable. By this reasoning, renewable resource technology clearly provides an economic value for society. However, none of the analytical tools currently in general use in the energy industry for performing engineering economic evaluations of power generation purchase alternatives contain a mechanism for including this long term economic value in cost-based decisions. This inadequacy in the analytical tools produces a consistent, though not necessarily desirable, result: except in the case of a site remotely located from both the utility grid and nonrenewable fuel supplies, renewable resource technology does not appear to be the economic choice. This is the most critical issue affecting the growth of the renewable resource industry, because in most cases there is no apparent economic incentive for the purchase of renewable resource technology despite the fact that there is an economic value associated with utilization of renewable resource technology.

Outside of the energy industry, for example, in the residential energy use sector, similar factors affect the growth of the renewable resource industry. For a homeowner or landlord in the industralized nations of the world, electricity and heating/air conditioning (from nonrenewable fuel sources) are generally readily available on a "pay as you go" basis without the need for capital investment. By contrast, renewable resource based electricity or heating/air conditioning requires a substantial investment in equipment on the part of the homeowner or landlord. When relatively small periodic payments for energy usage are compared to the large one-time up-front capital outlay for energy equipment, the economic tradeoff favors payment for usage rather than purchase of equipment except over sufficiently long time periods, and standard engineering economic evaluations apply a discount to future values. So here again, the long term economic value of the renewable resource technology is not adequately considered in the cost analysis. Ironically, renewable resource technology, particularly solar thermal and photovoltaic technology, is especially well-suited to residential applications because of the relatively small energy requirements for typical residences. However, the perception that renewable resource technology is uneconomic for residential applications negatively influences the buying decisions and thus has an adverse effect on the growth of the renewable resource industry. This is another key issue.

A brief examination of the major participants in the energy marketplace reveals other issues affecting the growth of the renewable resource industry. First consider the manufacturers of conventional, nonrenewable resource fuel utilizing equipment: these manufacturers stand to lose significant revenues if renewable resource technology gains enough acceptance to replace their equipment. These manufacturers are, not coincidentally, the original developers of the analytical models used to evaluate power generation purchase alternatives. It is therefore quite understandable why these models do not adequately value renewable resource technology alternatives. (Notable exceptions are for hydro, biomass and waste alternatives, which utilize older, conventional technology supplied by the same manufacturers.) In general, though, conventional equipment manufacturers have more reason to speak disparagingly of renewable resource technology than they do to advocate it.

Nonrenewable fuel suppliers have even less reason to promote renewable resource technology. Many oil companies recognized the threat during the 1970's and determined that diversification into renewable resource technology could ensure their long term future. Drops in oil prices later left some of these same firms strapped for cash, and they withdrew their financial support from the renewable resource technologies, causing a significant shakeout in the industry in the early 1980's. This has been another negative factor in the growth of the renewable resource industry.

Electric utilities, as already stated, have little or no economic incentive to invest in renewable resource technology over nonrenewable technology. They have, however, been active in developing and in demonstrating technical feasibility of the technologies. The orientation of the electric utility industry toward large central station power generation technology has prevented the utilities from becoming avid purchasers of the technologies, though, so again there is a significant negative factor in the growth of the renewable resource industry.

Industrial, commercial and residential users of power have, for the reasons stated earlier, not bought renewable resource technology because it is perceived to be less economic. Tax credits and the Public Utility Regulatory Policy Act (PURPA) created some economic incentives for investment in renewable resource technology, but did not create enough incentive to give renewable resource technology an advantage over nonrenewable technology.

The major challenge for the renewable resource technology industry is to overcome all of these negative economic factors. The industry has struggled along serving very small market niches in the United States (for example, power for remotely located vacation homes) and the larger markets available in developing countries which do not have extensive utility grids. However, rapid growth in the United States will require either drastic price increases in conventional fuel based power, drastic cost decreases in renewable resource based power due to technological advances, or the creation of significant economic incentives by the government.

I recommend the following actions be taken by the government to create economic incentives for the growth of the renewable resource industry:

- Reinstate tax credits for residential investment in renewable resource technology.

- Institute tax incentives for investment in renewable resource technology by small commercial users of power.

- Strengthen PURPA through legislation which increases the amount paid by utilities to qualifying cogenerator facilities; i.e., redefine the utility purchased power price and avoided cost concept.

- Institute tax credits for utilities which in effect subsidizes investment in smaller, decentralized, renewable resource power generation equipment. A specific program for such investments would encourage utilities to act as financiers for homeowners, landlords, or small commercial users who wanted to install renewable resource equipment in grid-connected applications. The renewable resource equipment would provide the bulk of the users' power needs, and the grid connections would allow for provision of backup power. The users would pay the utilities for the installations over time, thus ensuring a long term revenue stream for the utilities. The decreased power demand in the residential and commercial sectors would enable the utilities to provide power for an increasing number of industrial users without requiring as much investment in new power generation plants. [This is only a very rudimentary outline of a complex arrangement which would take more space to describe than can be done in this testimony.]

In conclusion, I would like to emphasize that any measures taken in an attempt to balance the economic inequities operating in the renewable resource marketplace must consider the long term needs of all of the participants. While I have tried to make specific recommendations, I have also limited the scope of my proposals to the creation of economic incentives for industry growth. There are, of course, other factors besides economic ones (technological development, for instance) which are affecting the growth of the renewable resource industry. I have chosen to limit my testimony to economic issues and proposals because I feel that the economic area is the one most appropriately addressed by the government.

July 13, 1987

The Honorable Wyche Fowler
Vice Chairman
Subcommittee on Research & Development
United States Senate
Washington, DC 20510

Dear Senator Fowler:

Integrated Communication Systems, Incorporated, is pleased to take part in the hearings being held in Atlanta today by your subcommittee. ICS submits this letter and the attached literature for the record, to further explain the Advanced Energy Management (AEM) features of its TranstexT® System which are being demonstrated today, and to express its views concerning this most pressing set of issues you have identified. ICS applauds the intent of your proposed bill, the "Renewable Energy and Energy Conservation Technology Competitiveness Act of 1987," and commends your efforts to generate directed, national insight into development of technology related to renewable resources and other advanced energy assets.

ICS is basically a Research and Development cooperative venture, dedicated to developing to commercial reality what is considered to be a very valuable and immediately available national energy asset - extant facilities. The TranstexT AEM faculty is a demand side tool, demonstrably capable of smoothing out the peaks and valleys of electric energy production and consumption, which today signal less than optimum operation of the existing plants and grids. It enables power producers and users to engage a sophisticated pricing mechanism, and thus affords maximum flexibility in consumer choices for the subscribers, as well as enabling suppliers to accurately forecast immediate consumption and longer-term trends. As a microeconomic demand-side planning guide, and a macroeconomic supply-side planning tool, it will indeed permit those valleys to be filled and the peaks to be clipped and thus defer the need for additional generating facilities.

ICS is in the forefront of developing usable systems to transform theoretical solutions to real and pressing electric energy concerns. We invite you and your colleagues, and of course the committee staff, to continue to follow the progress ICS and its constituents are making. We would be pleased to provide periodic updates regarding our activities. With best wishes,

Sincerely,

INTEGRATED COMMUNICATION SYSTEMS, INC.

Paul E. Spaduzzi
Group Vice President,
Business Development & Energy

**Integrated
Communication
Systems, Inc.**

1000 Holcomb Woods Parkway, Suite 412, P.O. Box 767968, Roswell, Georgia 30076 (404) 641-1551

ICS
TranstexT®

INTRODUCTION

Integrated Communication Systems, Inc. (ICS) is a communications technology research/development and marketing company working with 30 of the nation's largest electric utility companies; the major independent telephone companies and six of the seven Regional Bell Operating Companies; major banking institutions, national service providers, and others.

ICS originated from a consortium of major corporations, primarily in the electric utility, telecommunications and data processing industries formed to study advanced energy management.

Founded in 1983 and based in Atlanta, ICS developed, and is now demonstrating in over 100 suburban Atlanta homes, TranstexT, an interactive, digitally delivered transactions and information services network utilizing the TV set and touch-tone telephone. A key feature is the advanced energy management application. A commercial rollout is planned in early 1988.

ICS has been demonstrating the Beta TranstexT system in the Atlanta community of Roswell, Georgia. TranstexT, a transaction-based "premium value-added" network, utilizes Southern Bell's "PulseLink" public data network, in combination with a microcomputer device called a "Com'Set". The Beta TranstexT Com'Set, which currently interfaces to a standard touch-tone telephone and TV, links the customers participating in the demonstration to a variety of consumer services and vendors such as Georgia Power, Southern Bell, Georgia Telco Credit Union, Merrill Lynch Company and the local cable TV provider. The TV set displays screens of information and consumers use the phone keypad to respond.

The Beta system offers five main applications each corresponding to different buttons on the telephone keypad. TV/entertainment, transactions, information, communications and home (energy) management applications offer the customer service options never before available in the home. Energy "discounts" and/or easy access to virtually any consumer information service provide good examples of how TranstexT can be used.

— INTEGRATED COMMUNICATION SYSTEMS, INC. —

During the past year, Integrated Communication Systems, Inc. (ICS), has made significant progress toward the commercialization of the TranstexT® system and obtained additional investment from companies who are critical to its success.

In 1986, ICS continued its Beta demonstration of TranstexT, an innovative transactional oriented service for residential customers offered via the public packet switched telephone network. Specifically, TranstexT allows the Beta customers in Roswell, Georgia the capability of a smart energy home that is interactive with Georgia Power, the electric utility. Through the TranstexT energy system, the customer can take advantage of a premier variable pricing rate offered by Georgia Power which allows them to control their energy bill and needs before they get the bill. Using a touchtone telephone and the television the customer also has at his finger tips; bank at home capabilities, smart phone services, home shopping, pay-per-view cable, news, information and stocks.

The Beta demonstration participants are extremely enthusiastic about TranstexT and have taken every opportunity to voice their approval. They have concurred with ICS' initial assumption that advanced energy management is the economic justification for having the system and also have found that banking and the other on-line services are valuable, convenient and very easy to use.

The information gained in the Beta test has been invaluable and is already being put to use in the design and development of the commercial TranstexT system. The ICS mission is:

> "to profitably introduce emerging information system technologies to higher levels of mass marketing and transaction process; in particular, to definitively explore Advanced Energy Management as both the long sought entry into a digital network infrastructure, as well as a timely marketing tool for the electric power industry".

Within the Beta home management applications, Georgia Power is offering, for the first time in this country, a variable energy price to residential customers. Called the VSP-1, the innovative Georgia Power rate provides four pricing tiers. Until now a variable, or spot rate, would make little sense; the consumer would not get up in the middle of the night to turn off his swimming pool heater just to save a few cents each time the rate changed. However, the consumer might program his fully automated TranstexT system to gain meaningful aggregate savings or get more comfort, convenience and choice for each energy dollar spent.

Other features offered through the Beta TranstexT system include premium cable channel subscriptions available on a monthly basis, information retrieval through the Atlanta Journal/Constitution and Dow Jones, securities information from Merrill Lynch, banking through Georgia Telco Credit Union and Fulton Federal including funds transfer and bill payment, and interactive video advertising, i.e., broadcast TV promotions coupled with a telco-based electronic delivery system.

The Beta TranstexT deployment was built upon Southern Bell's recently tariffed PulseLink local packet data network. Commercial/Production version can work on a digital or analog/voice networks. Operating under special FCC permission, ICS has teamed up with BellSouth to configure certain "enhancements" that pave the way for systems like PulseLink to become easy and economical enough for everyday consumer use. The Roswell Beta TranstexT system marks the first time that these enhancements, called "protocol conversions", have been allowed within a major American telephone network.

Currently, over 50 companies are working with ICS, including many of the nations' leading electric utility, telecommunications, and cable TV companies. Through its "Participant Development Program" (PDP), ICS has made available to all program members the knowledge base that it is building. This "shared-risk, shared-reward" approach has been attractive to utility and other consumer service industries because of the mass market potential of the TranstexT system.

Toward that mission, ICS is in 1987 organized into three distinct areas which will focus on the development of the TranstexT components. Specifically, ICS efforts will focus within three functionally related profit centers:

- TranstexT Energy Group
  (Advanced Energy Management)
- TranstexT Network Group
  (Enhanced local digital telephone networks)
- TranstexT Services Group
  (Field & operational support services)

The accomplishments have been significant in each of these areas. The TranstexT Network Group is funded to design, develop and implement for two of the largest Regional Bell Operating Companies a system that will enhance their digital networks by allowing a universal, highly cost efficient gateway to their network. A precedent setting move was also recently made by BellSouth. Based on ICS recommendations, it has announced the formation of BellSouth Advanced Networks. This affiliate will create for BellSouth a leading market position in untariffed information network services, i.e., the public packet switched network. This marketing entity has contracted with the ICS network group to provide all project management services.

On the energy front, the TranstexT Energy Group has signed developmental contracts with Westinghouse Electric, Johnson Controls and Southern Company for the commercial energy products. These manufacturers will also provide the distribution service and warranty channels for the TranstexT commercial energy products, i.e., smart meters, modems, thermostats, controllers and access terminals. Market reaction to the product/service line has been extremely encouraging, as the energy group is presently negotiating contracts with eight of the United States' largest electric utilities to implement the system in 1988 and beyond. This is in addition to a contingent commitment by the Georgia Power Company to install 5000 of these TranstexT systems in their customers' homes/businesses beginning in late 1987.

Based on its achievements and the potential of ICS/TranstexT, ICS has attracted two new major funding partners to its consortia. Westinghouse Electric Corporation has been actively involved with ICS since last June and American Electric Power - one of the top five electric utilities in the country - has obtained approval from the Securities and Exchange Commission to take a significant equity position in ICS.

With these accomplishments, ICS feels that it is ideally positioned for 1987/1988 and beyond. Its primary markets, electric and telephone utilities, have provided significant funding and are anxiously awaiting the availability of the commercial systems which will begin to be available in 1987. ICS has increased its lead in the area of advanced telecommunications and energy and looks forward to a rewarding and profitable near term future.

ICS
PARTICIPANTS

ELECTRIC UTILITIES

- AEP American Electric Power *
- PSO Public Service Company Of Oklahoma
- Detroit Edison
- Middle South Services
- Northeast Utilities NU
- PG&E
- PacifiCorp
- NM Niagara Mohawk
- Puget Power
- CP&L Carolina Power & Light Company
- SDG&E San Diego Gas & Electric
- Southern Company *
- SCE Southern California Edison Company
- Vepco
- PSE&G Public Service Electric And Gas Company

FINANCIAL INSTITUTIONS

- C&S
- FirstAtlanta The First National Bank of Atlanta
- [illegible]
- NCNB

TELEPHONE COMPANIES

- Ameritech *
- Bell Atlantic
- BellSouth *
- GTE General Telephone Company of Florida
- Pacific Bell
- Southwestern Bell Telephone
- Southern New England Telephone
- United Telecom
- NYNEX

INFORMATION PROVIDERS

- COX
- Dow Jones & Company, Inc. *
- [illegible]
- Hallmark
- Travel Incorporated
- Merrill Lynch *
- HEERY *

DATA SERVICE COMPANIES

- ADT *
- Control Data
- GTE *
- NDC *

ENTERTAINMENT

- Group W Cable
- Coca-Cola *
- OMNI Cable TV Corporation

MANUFACTURERS

- Comdial
- TeleMeter
- Westinghouse *
- Databit

* REPRESENTED ON ICS' BOARD OF DIRECTORS

TranstexT® ADVANCED ENERGY MANAGEMENT

ICS has spent considerable resources in researching the TranstexT Advanced Energy Management (AEM) concept, and offers a broad range of consulting services in its research efforts to: 1) evaluate the local potential for electronically-delivered services, including Advanced Energy Management; 2) develop and implement a variable spot rate; and, 3) develop the market, business and operation plans necessary to implement a 200-point pilot of the TranstexT AEM system.

TranstexT Advanced Energy Management (AEM) includes features that allows the utility to:

- implement innovative pricing,
  (variable time of day, variable spot pricing, etc.)
- to selectively market energy in times of high excess capacity,
- deter demand in times of low reserve capacity (peaks),
- implement remote meter reading,
- improve load research,
- better align supply and demand,
- give the customer choices and control of their energy use and cost.

Since 1983, ICS has increased its credibility in the electric utility industry arena through its unique research and development programs in the areas of electric Demand-Side Management (DSM) technology, implementation of Variable Energy Pricing (VEP), consumer research and field demonstrations. ICS is currently the only organization in the United States testing VEP in an actual consumer demonstration. The 107-point residential test uses interactive communications with the sponsoring electric utility. Simulation research using the same technology has also been conducted by ICS in several markets.

ICS has been instrumental, not only in research and development, but also in providing a forum for some thirty electric utility companies nationwide, all of whom are investigating DSM implications for their geographic-specific electric demand-shaping objectives over the next two decades. Twelve of the top twenty-six, six of the top ten, including the two of the largest (Southern Company and American Electric Power) electric utility holding companies in the country are among this group.

These utilities have an audience with ICS through the Participant Development Program, whereby Participants have access to proprietary information concerning the 107-point field demonstration in Roswell, Georgia, which encompassed Southern Company's implementation of variable energy pricing in one of Georgia Power's service areas. The demonstration itself was being supervised by ICS's subsidiary, The Atlanta TranstexT® Development Company (ATD).

The TranstexT system includes electronic delivery of residential information services via the public packet-switched telephone network. Demand-Side Management services and Variable Energy Pricing are the premier services provided; the system also offers several other interactive information services including home banking, entertainment programming, and on-line classified ad services.

Following the Roswell/ATD demonstration and the integration testing of the production version of the TranstexT AEM system, will be a 5000-point Advanced Energy Management system trial sponsored by Georgia Power. This implementation is currently in the planning stages, and is scheduled to produce the first of 5000 on-line points. Further, ICS has been involved in a number of feasibility tests for large electric utilities in other parts of the United States. Initial data from a these tests show that the TranstexT AEM system can produce significant benefits to the electric utility, such as deferring generation plant expansion, while providing the consumer control over his electric bill.

Since its inception, ICS has remained close to its primary market, electric utilities in order to develop DSM programs that benefit them and and their customers. The company has collaborated in the development and testing of research concerned with how electric utilities will individually develop programs to continue utility company progress through the turn of the century.

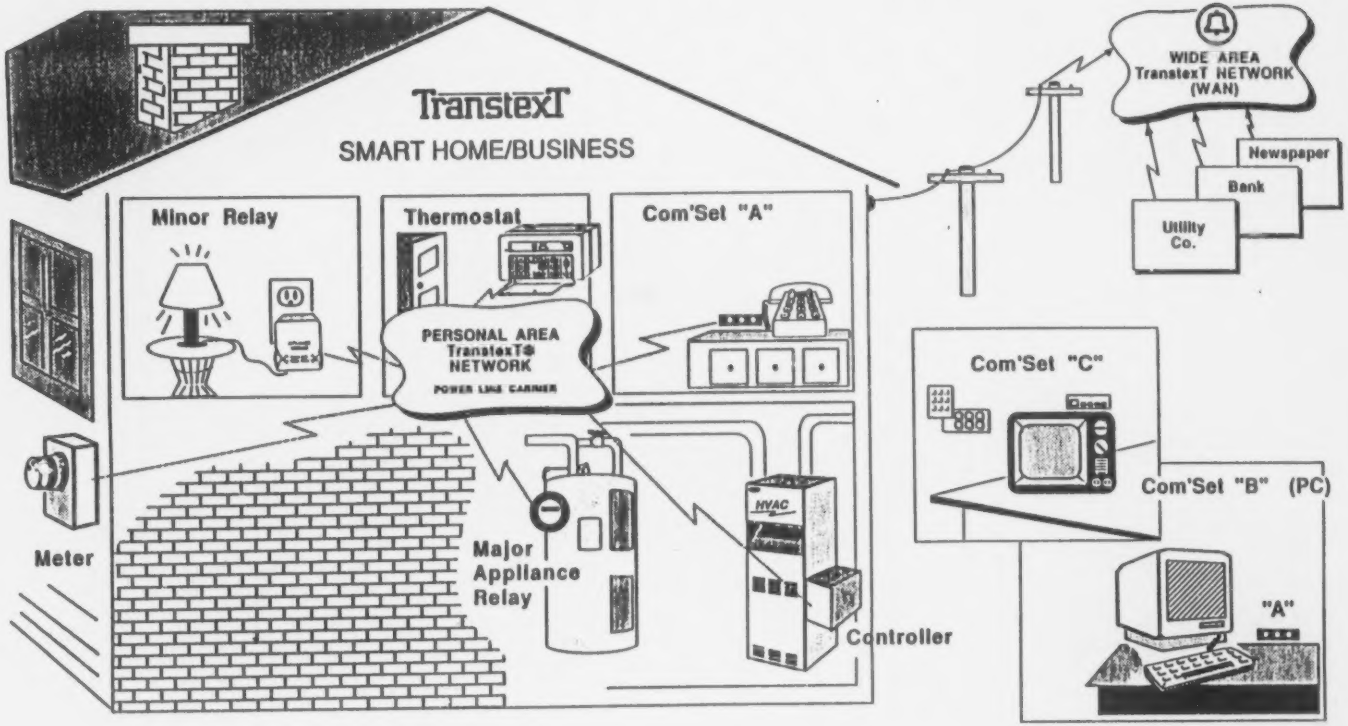
ICS has addressed state and federal regulatory bodies regularly to petition for support of variable and other innovative energy pricing structures, and to educate regulators of the shared benefit for electric customers in adopting such pricing schemes. Also noteworthy, ICS has begun negotiations leading toward the joining of forces with the Electric Power Research Institute (EPRI) to define a deployment strategy for Advanced Energy Management systems. ICS has also been chosen as a sub-contractor for the EPRI Prism project. The scope of the Prism project includes conducting the market research for a large priority pricing study, and advising on the technical aspects of providing price signals to electric utility customers.

ICS has designed and conducted market research hand-in-hand with its internal technical services group and the electric utility industry's largest suppliers of equipment. ICS is responsible for the successful development and deployment of a working DSM system using Variable Energy Pricing, and a line of advanced Customer Premise Equipment (CPE).

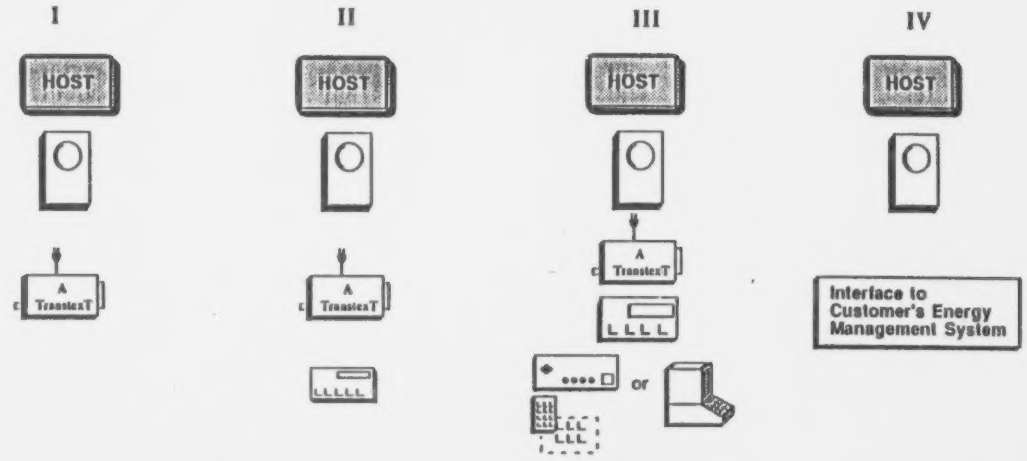
In addition to success in implementing DSM systems, ICS has a wealth of experience in software development for electronic data collection and statistical analysis, and in dealing with the technical parameters of electronically interfacing both with the residential customer and residential electric appliances. ICS has over fifty years total electric utility experience, with particular emphasis on DSM. ICS also has a strong track record in developing market research survey design, and executing these designs (for both electronic and manual data collection), which can offer the electric delivery, use and value of electricity over the next decade.

With five years of experience in AEM research and development, ICS' participation would be of greatest benefit in developing a variable rate structure, designing the market research protocol, planning and implementing a 200-point research pilot and analyzing the results.

TranstexT. ADVANCED ENERGY MANAGEMENT SYSTEM


TranstexT
SMART HOME/BUSINESS
Minor Relay
Thermostat
Com'Set "A"
PERSONAL AREA TranstexT® NETWORK
POWER LINE CARRIER
Meter
Major Appliance Relay
HVAC
Controller
WIDE AREA TranstexT NETWORK (WAN)
Newspaper
Bank
Utility Co.
Com'Set "C"
Com'Set "B" (PC)
"A"

TranstexT Advanced Energy Management
Product Packages


I
II
III
IV
HOST
HOST
HOST
HOST
A
TranstexT
A
TranstexT
A
TranstexT
or
Interface to Customer's Energy Management System

	I	II	III	IV

Functionality:	• VSP Billing
	• Remote Meter Reading
		• VSP Billing
		• Remote Meter Reading
		• Automated VSP Energy Optimization
		• Control Of HVAC & Appliances
		• Energy Bill/KWh Forecast
		• Bill Comparison
			• VSP Billing
			• Remote Meter Reading
			• Automated VSP Energy Optimization
			• Control Of HVAC & Appliances
			• Terminal Access To Energy Control Devices
			• Terminal Access To Utility For:
			  • Enhanced Billing Features
			  • PR/Advertisements/Energy Tips
			• Terminal Access To ISPs
			• Full Screen Viewing
				{ Development Contract Offerings For Customized Solutions To Leverage Existing Equipment Investments }

Market Segment:	• Residential • Small Commercial	• Residential • Small Commercial	• Residential • Small/Medium Commercial	• Large Commercial • Industrial

Federal Programs for Research & Development of Solar Energy Technology

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Industry Analysis and Recommendations for Funding For FY 1988

Prepared by the
Solar Energy Industries Association

Above report available through:

Solar Energy Industries Association
1730 North Lynn Street, Suite 610 Arlington, VA 22209 Telephone: 703-524-6100

Introduction

While U.S. petroleum imports climb precipitously and contribute to the staggering U.S. trade deficit, U.S. policymakers remain complacent about the need to develop a national energy policy. The United States is the only industrialized country without an aggressive energy strategy to protect our economy and national security.

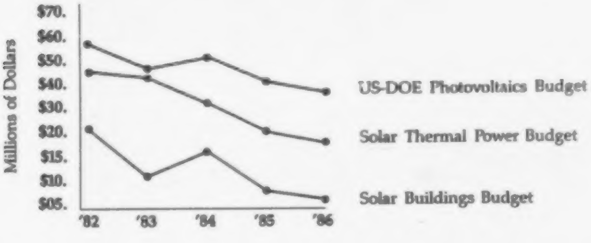
While the U.S. cuts its energy research budgets for both conventional and renewable energy technologies, our international competitors are increasing their federally-sponsored R&D in great anticipation of controlling the high-technology world energy markets in which the U.S. appears to have little interest. However, while Washington seems preoccupied with "competitiveness" issues, energy matters are somehow shuttled to the side of the trade discussions.

In 1985, the U.S. Department of Energy released a "white paper" which related that the United States, between 1975 and 1985, spent $4 billion dollars for solar and renewable energy R&D, and $2 billion for tax incentives. As a result of this R&D, the report states further, over $36 billion of petroleum was displaced by solar and renewable energy applications resulting from our government's effort. In 1987, the United States has a choice to maintain its minimal solar energy effort or to relinquish its lead to our international competitors.

The U.S. solar industry asks the Congress to take notice of our young American industry and give it a chance to reach its potential to provide domestic energy and offset petroleum imports in an environmentally benign fashion. Most importantly, solar energy will be an energy resource of the future. The real question is which countries will lead technologically and thus reap the potential multi-billion dollar market benefits of the future?

A review of the U.S. Department of Energy (US-DOE) R&D budget, in a graph below, shows the decrease in the U.S. solar buildings, solar thermal power, and photovoltaics program budgets over a five year period.

Trends in Federal Solar R&D



As you can see, the federal commitment for solar has dropped to a poı
where if the budget goes any lower, the U.S. research effort would be meanir
less. The United States must maintain level funding and work with the Office
Management & Budget (OMB) to incorporate the U.S. solar R&D funding effort
a multi-year funding cycle to insure some kind of stability. Otherwise the sm
U.S. solar R&D effort will be subsumed by those of our competitors before t
1990's.

The solar industry urges the U.S. Congress to establish national recomm
ment to a solar energy future. Federal and state governments must work coop
atively to promote our clean, safe power. The United States must not back aw
from a research effort begun when high energy prices and oil imports w
devastating our economy. Times again will change. Energy prices will rise, ener
imports will further damage our national economy, environmental concerns
increase, and policymakers and the media will once again be forced to deal w
an even more serious energy crisis.

The recommendations developed by the members of the Solar Energy Ind
tries Association provides a clear and realistic review of each line-item program
the U.S. Department of Energy's solar energy research programs. Our indus
went through a long and arduous process to review each solar research progr
and provide our recommendations totalling 95.6 million dollars for FY 88 (
chart below). Special thanks go to SEIA's Division Chairmen Dr. Barry Butler, J
Corsi, and Freeman Ford. We urge you to contact us for further information
elaboration on any of the enclosed recommendations.

Walter Hesse
President

Scott Sklar
Executive Dire

**The Solar Energy Industries Association recommendations for FY88 for
U. S. Department of Energy solar budget are:**

International	$ 1.5
Photovoltaics	43.1*
Solar Buildings	7.4
Solar Thermal Power	28.7
Other Program Items	14.9**
TOTAL RECOMMENDATION	**$95.6**

Note: Numbers expressed in millions of dollars.

(*) Represents core research program.

(**) Includes NATAS ($1.5), PV-USA ($7.5), Resource Assessment ($1.0), S
Equipment & Capital Building ($2.4), and Technology Transfer ($2.5).

INSERTS FOR THE RECORD FROM BILLY LOVETT, GEORGIA PUBLIC SERVICE COMMISSION

Speech for Georgia Cogeneration Society
February 11, 1987
William E. Lovett, Jr.

Thank you, ____. I have looked forward to this opportunity for several weeks. This is a period of dynamic change in the way our nation views its energy resources... and you are in the forefront of that change.

I was interested to read a recent report on this subject by Dean Witter Reynolds. It analyzed the current situation and concluded -- and I quote -- "The electric utility industry is in the throes of change, and the forces reshaping the industry are more advanced than generally perceived."

The report went on to enumerate some of these forces: construction cost overruns... abandonments... regulatory disallowances... court challenges... resistance to rate increases... and, significantly, competition from cogenerators.

It is your role in our changing energy climate that I want to talk with you about today. In the brief time we have, I want to share my view of where Georgia's energy situation stands today... and my thoughts on what we should be doing together to prepare for the future.

Let's begin by considering the present. The energy policies adopted in the 1970s were designed to reduce our dependence on foreign oil and gas. These policies resulted in a commitment by utilities to coal and nuclear power.

Today, coal provides 55 percent of the nation's electrical power, and nuclear has moved into second place... ahead of oil, natural gas and hydropower. Unfortunately, both coal and nuclear are now faced with severe regulatory and financing obstacles -- obstacles that threaten their ability to continue to meet growing demand.

Today we're enjoying lower oil prices... but I think we're already beginning to see that this is merely a short-term deviation from the rising price trend. In fact, our country's proven oil reserves are expected to last only about eight and a half years. And outside the Middle East, the free world's supply of known oil reserves is good for only twenty-two years at current consumption rates.

Georgia's situation is not unlike that of the nation as a whole. With the exception of some hydropower, our state is dependent on other states and foreign countries for its energy resources.

Petroleum and natural gas are piped to Georgia from the Southwest and Gulf Coast... Foreign oil tankers unload at Savannah and other nearby ports... Our two operating nuclear plants are fueled by imported uranium... and most of our electric power is generated from coal imported from Kentucky, Tennessee, Alabama, Illinois, West Virginia and Virginia.

Georgia ranks 12th nationally in energy consumption, and over the last twenty years we have experienced the fourth largest increase in per-capita energy consumption of any state.

In response to this growth, the Vogtle Nuclear Plant was licensed for construction by the NRC in June 1974. Since that time, the costs of the project have skyrocketed to the point that both the utility and the Public Service Commission have been forced to study whether it even makes sense to continue construction.

As you know, this scenario isn't unique to Georgia -- it is being repeated time and time again throughout the nation, as other states share our disappointing experience with nuclear power.

This isn't to say we ought to abandon nuclear power or any other existing source of energy. It is to say that the time has come for a comprehensive energy policy aimed at achieving the right mix of energy sources to sustain Georgia over the long term.

Our aim should be to develop an energy mix in Georgia that favors the least-cost alternatives. Many states have found that cogeneration and small-power producers are among the best of these alternatives.

Cogeneration in recent years has become the most successful means for businesses to become more energy efficient... and its advantages ought to be an important part of our overall state energy strategy. Cogeneration can be traced back to the 1800s, but its applications today are benefitting more industries than ever. In fact, in the last few years cogenerated power has surged to seven percent of the U.S. electric supply.

The office of technology assessment has estimated that more than 39,000 megawatts of cogeneration currently is available... and that a potential for as much as 200,000 megawatts exists by the year 2000 -- that's equal to 200 large nuclear plants!

Georgia today has no formal energy plan. The only planning that exists is done independently by the various utility companies. In fact, decisions by utilities to invest in power plants are made without any regulatory approval or supervision. This represents a serious shortcoming in the way we respond to our energy needs.

By its very design, the Public Service Commission regulates utilities in a reactive, rather than proactive, manner. The Commission has no say-so in whether a utility may invest in a new plant... it only determines what kind of return will be allowed

Never has the state attempted to examine its future energy needs and make plans for meeting them. The state has no official involvement in the planning process; therefore, there is no objective evaluation of present energy resources. . . and no study of whether alternative resources might be integrated into the overall mix to achieve lower costs.

Presently, two major electric plants are being planned for Georgia by utility companies acting without benefit of a state energy policy. Savannah Electric has joined with a group of out-of-state utilities to consider a new generation site -- possibly in central Georgia -- for a 600 megawatt coal plant. And Oglethorpe Power is considering a 600 - 700 megawatt pump-storage hydro facility in Walker County.

Many states have enacted legislation mandating careful energy and resource planning. The states that have been most successful with such planning have sought to develop fully integrated, least-cost strategies. These strategies encourage and reward conservation, while providing incentives for cogenerators and small power producers that utilize renewable resources.

When states allow all possible energy sources to compete fairly in the marketplace, the lower-cost, most efficient producers ultimately win out. A fully integrated energy plan considers all options in addition to traditional generators. This kind of least-cost energy planning turns to more expensive power sources _only_ after lower-cost options are exhausted.

Illinois, Texas, Nevada, Wisconsin and several Northwestern states are among those that have adopted comprehensive energy planning policies. A majority of U.S. states have the authority to deny a plant construction permit... Twenty-three states have conducted their own, independent demand forecasts for a 10 - 20 year period.

Georgia has fallen behind. And if steps are not taken in the right direction today, we will pay the price for our mistakes in years to come.

I have proposed that we develop a long-term energy plan that might include any or all of five elements:

1) Legislative approval of special enterprise zones to provide state tax incentives for companies in economically depressed areas to hire and train workers to develop alternative energy sources... from biomass, for instance.

2) The creation of a State Alternative Energy Corporation that would make low-interest loans to textile companies, farmers and other targeted industries to help them convert to lower-cost energy supplies. As you know, construction financing has been a major obstacle to converting to self-generated energy.

3) The creation of a State Energy Planning Unit, with responsibility for least-cost planning, independent forecasting, plant certification and plant construction review.

4) The development of a state-sponsored research center charged with exploring new energy options. We must recognize that Georgia has undeveloped resources that can become a vital part of a balanced mix of energy sources.

and, 5) Georgia needs an overall, long-term energy plan . . . a plan that specifies objectives and priorities. . . a plan that includes decisions on cogeneration, third-party sales, standby rates, buyback rates, hookup charges, deregulation, wheeling electricity from business to business, and other important questions.

For at least seven years, we have talked about energy planning -- but we've done nothing about it. The Public Service Commission and the Legislature can take action on some of these issues, but have been hesitant to take positive action for several reasons, one of which is a reluctance to deal with the issue on a piece-meal basis.

Today, I am proposing that we take action. I believe all parties involved in energy production should join together in a neutral forum to fully explore Georgia's energy problems. Small cogenerators and big utilities alike should be represented in the process -- a summit, if you will, to begin work toward a long-term energy policy for Georgia.

I have spoken with officials at Georgia Power and Savannah Electric, and they are willing to participate in such a discussion. I also have talked with Georgia Tech's Southeast Negotiation Network about providing an independent forum to foster strategic planning and develop a constructive dialogue between all parties.

I know that many cogenerators have been frustrated in their dealings with utilities on such matters as standby power rates and wheeling. They have also been frustrated with the Public Service Commission and the Legislature. That's why I feel it's important to involve the professional negotiators at Tech.

The methods used by these negotiators have been employed successfully to develop a national coal policy . . . to explore solutions to acid rain. . . to establish a hazardous waste policy for South Carolina. . . to set an annexation policy in Virginia. . . and to establish environmental regulations within the EPA.

I am willing to arrange an initial meeting of representatives of all parties to examine the feasibility of this approach. If we then agree to go ahead with the process, our goal should be nothing less than a policy recommendation for consideration by the state legislature. Above all, we should set a realistic deadline for completion of the project, so that we make certain our efforts produce results.

I am convinced that the best solutions to our state's future energy needs will come from the private sector. A policy that encourages competiton and considers all alternatives will result in lower energy costs, more jobs, new businesses and a boon to Georgia's economy. Such a policy should be put forth by the private sector, adopted by the General Assembly and enforced by the appropriate state regulatory agencies.

I can't tell you exactly what form an energy policy might take. But I do know that cogeneration and small power facilities are among our best alternative resources. Regardless of whether these facilities are owned by utilities, industry or individuals, their advantages lie in their ability to utilize inexpensive, readily available fuels. . . while providing lower cost energy and new jobs to areas that need them the most.

No single new resource will provide the answer to all of our needs. But the aggregate potential of so many feasible alternatives -- given the chance -- can make a real and lasting difference for Georgia.

The Role of Energy in a Changing Environment for Agribusiness

by

William E. Lovett

Vice Chairman

Georgia Public Service Commission

244 Washington Street, SW

Atlanta, GA 30334

Presented at the Summer Meeting, Agricultural Economics Association of Georgia, Atlanta, Georgia, June 11-12, 1986.

Introduction

U.S. farmers are facing very difficult and challenging times. Increased competition from abroad during the 1980's has significantly reduced farm exports. U.S. farm product exports dropped a record amount in value and volume in 1985 to their lowest levels in nearly a decade. The lower volume and declining world prices reduced value by $8.8 billion to $29 billion. Declining export value and increasing import value reduced the U.S. agricultural trade surplus to $9.1 billion, its lowest level since 1974 (USDA, FATUS, 1986). Declining world food prices have increased farmer's dependency on government subsidies and elevated U.S. stockpiles of surplus corn, wheat, and other food commodities beyond desirable levels. Many businesses linked to U.S. agriculture are also suffering. Overall employment in the farm equipment industry has fallen by 50 percent since 1979. During the first one-third of 1985, 20 agricultural banks failed. Farm debt has grown from $182 billion in 1981 to $213 billion in 1985. Meanwhile, land values have fallen 19 percent since 1981.

This situation is not likely to change soon, since increases in world food supplies are expected to continue. The U.S. faces strong competition in wheat, corn, rice, soybeans, and cotton. Each of these major export commodities is being produced by at least one country at or below the U.S. average production cost (Office of Technology Assessment). Recent government reports suggest that any cost advantage that the United States may have enjoyed in these commodities is now tenuous.

The Food Security Act of 1985 is designed to make U.S. agricultural commodities more competitive on the world market by lowering price supports and imposing new production controls. In addition, the 1985 farm bill mandated

USDA, Environmental Protection Agency (EPA) and others to study emerging technologies that have the potential to increase production efficiency and develop new uses for farm products. The adoption of these technologies will be critical for strengthening the United States' lagging ability to compete in international markets. Avery (1985) wrote "Researchers need to look at farmland not only in the traditional sense but also as a potential source of biomass and the various kinds of complex chemical feedstocks that could be produced from genetically engineered plant life." Advances in biotechnology have increased the production efficiency of traditional crops and are leading the way to new agricultural products. Potential industrial products include a biodegradable plastic that has similar properties of polypropylene. Lactic acid can be made from biomass (cellulose, starch or sugars) and used in the production of petrochemicals. Vegetable oils rich in erucic acid have desirable properties for a variety of industrial applications such as lubricants in continuous steel casting, marine lubricants and in the manufacture of rubber additives. Scientists are also investigating the potential of using biomass in the production of nylon, new sources of waxes, adhesives, steroids and other products.

Many researchers and policy makers believe the most promising use of biomass is providing renewable resources for future energy production. Biomass already contributes as much energy as nuclear or hydropower -- about four percent of the U.S. total. However, biomass energy is produced on a very decentralized basis and hence is much less visible. Since the energy crisis of the seventies, much attention has been given to the production of fuels from biomass. However, past studies have shown that most biomass fuels are not economically viable given today's prices for fossil fuels (Hiler and Stout, 1985). This situation is likely to change given the recent Environmental

Protection Agency lead phase-out order in which fuel alcohol is expected to play a significant role as an octane enhancer for gasoline. Also, a sixty-cent per gallon duty has recently been imposed on much of the imported alcohol. It would seem that these actions, along with advances in conversion technologies, will provide a stable market for alcohol fuels.

Natural gas supply problems and the Arab oil embargo demonstrated the need for a new national energy strategy to encourage alternative sources of energy to reduce dependence on uncertain petroleum supplies. Although recent oil prices have dropped considerably, this is likely a short term deviation from the rising price trend. Sufficient proven oil reserves in the U.S. are expected to last only eight-and-a-half years, and outside the Middle East the free world's supply of known oil reserves is less than 22 years at current consumption rates (Oil and Gas Journal, December 31, 1984, p. 33). Energy policies adopted in the seventies to reduce foreign dependence prompted utilities to make commitments to coal and nuclear power to replace oil and gas. Coal now provides 55 percent of the nation's electrical power and nuclear power has moved into second place, providing a greater amount of electricity than oil, natural gas or hydropower. However, both are now facing severe regulatory and financing obstacles that are threatening their ability to help meet growing demand for electricity in years ahead (Finger). It has become obvious that the solution to the oil shortage will involve use of a variety of energy sources, of which biomass energy should play an important role.

The nation's changing energy environment could have profound impacts on the economic and social structure of U.S. agriculture. The purpose of this paper is to examine the economic opportunities that may result from increasing the use of Georgia's biomass resources. This goal is accomplished by addressing three questions. First, what biomass energy sources can be economically provided by Georgia's agricultural sector? Second, what are the potential economic benefits of biomass use? Third, what can be done to stimulate biomass energy production in Georgia?

Georgia's Current Energy Situation

With the exception of some hydropower, Georgia is totally dependent upon other states and foreign countries for its energy resources. Georgia has never produced any crude oil or natural gas and its small amount of coal production is exported as a source of high-quality coke to foreign steel industries (Gonzales). Petroleum products and natural gas are pumped through pipelines from the Southwest and the Gulf Coast. Foreign oil tankers unload at Savannah and other nearby ports. The State's two operating nuclear plants are fueled by imported uranium. Most of Georgia's electrical power is generated from coal, which is imported from Kentucky, Tennessee, Indiana, Alabama, Illinois, and Virginia. Georgia is ranked 12th in energy consumption in the nation and has experienced the fourth largest increase for any state in per capita energy consumption during the last 20 years (DOE, 1983). Total energy expenditures in Georgia increased from $2.199 billion in 1972 to $10.138 billion in 1982 (DOE, 1983). Responding to Georgia's energy needs, Vogtle nuclear generating station was licensed for construction by the Nuclear Regulatory Commission on June 28, 1974. The Georgia facility consists of two 1,160-megawatt nuclear power units. Commercial operation is anticipated by Georgia Power Company (GPC) to commence in June 1987 for Vogtle 1 and September 1988 for Vogtle 2. Both the final capital cost estimate and the sunk costs of the Vogtle project have increased substantially over the past year. At the beginning of 1985, the GPC estimate of the final project cost was $7.2 billion. Now, estimates range between $8.4 billion (GPC) and at least $9.2 billion (O'Brien-Kreitzberg & Associates, March 1986). Operations and maintenance costs of nuclear facilities have also increased substantially during Vogtle's construction period. On an industry-wide basis, these costs have increased from $5.6 per kilowatt per year in 1970 to about $56 per kilowatt per year in 1984 (Bernow, et al.). This is an annual escalation rate of about 20 percent over this period, or about 12 percent above inflation. These unanticipated cost increases led to several recent studies analyzing the economic benefit of continuing the Vogtle project (Georgia Power Company; Kennedy and Associates; and Bernow, et al.). The most recent study was conducted by the Energy Systems Research Group (Bernow, et al., 1986) for the Georgia Office of Consumers' Utility Counsel. This study compares the costs of completion and operation of the Vogtle facilities versus their abandonment and replacing the generating resources with coal units. The study concluded the benefits for Georgia rate payers of cancellation would range from $259 to $641 million with GPC earning a full return on sunk costs, and from $2134 to $2515 million if sunk costs were shared. Georgia is not the only state that has had disappointing experiences with nuclear power. Safety and environmental problems have delayed and discontinued construction of nuclear plants throughout the country. Regulatory delays after a plant is nearly completed can lead to additional costs of more than $1 million a day (Finger).

Financial and regulatory uncertainties have created disincentives for investing in large nuclear as well as coal-fired power plants. Coal-fired power stations have also experienced financing and regulatory problems in recent times (Vaughan). The acid rain problem and concerns over the buildup of carbon dioxide in the atmosphere resulting in a "greenhouse effect" will almost certainly be the subjects of future costly government regulations (Fenn, Williams, and Cogan). Consequently, Georgia and other states are now looking to renewable energy alternatives, of which biomass will play an important role in future energy development.

Biomass Technologies/Fuel Products

A number of alternative biomass conversion technologies are being developed. These include:

(1) direct combustion and thermal-chemical gasification to produce heat, steam or electricity;

(2) biological gasification (anaerobic digestion) to produce methane gas for use in engine or heating systems;

(3) pyrolysis to produce a crude form of oil and charcoal;

(4) thermochemical processing of oil crops to produce a diesel substitute; and

(5) fermentation of sugars (derived from sugar crops, starch crops, or cellulose) to produce ethanol for use as an octane enhancer in gasoline.

Several of these technologies also can produce products other than fuel.

Biomass Energy in Georgia

Biomass consists of vegetation and waste materials containing large amounts of organic matter. Examples include agricultural crops and residues, forestry crops and residues, animal wastes, aquatic plants and municipal solid wastes. This paper will focus on biomass associated with agricultural crops, livestock and poultry wastes and forestry crops.

Agricultural Crops

Many agricultural crops and residues can be used to produce ethanol for on-farm use and provide new markets for cash crops in Georgia. The production of liquid fuel alcohol from corn and grains is not a new idea. The use of alcohol and gasoline mixtures was widespread in the Midwest during the Great Depression and again in the seventies when gasoline prices reached their peak. The leveling out of oil prices has made alcohol less attractive as a gasoline substitute but with the recent Environmental Protection Agency lead phase-out order, it could play a significant role as an octane enhancer. In addition, all blended ethanol entering the country is now (as of November 1, 1985) subject to a sixty-cent per gallon tariff in addition to a three percent ad valorem duty. This action should reduce Brazil's alcohol exports (Brazilian yearly exports of fuel alcohol has been estimated somewhere between 83 million and 125 million gallons) and stimulate domestic production.

Grain is not the only crop in Georgia with liquid fuel potential. The Tennessee Valley Authority (TVA) is currently studying an agri-refinery concept which is based on use of forage crops, such as Serecea lespedeza, alfalfa, and Bermuda grass. Feedstock is processed into multiple products such as food, animal feed, energy, and chemicals. This is parallel to wet milling of corn into oil, protein, and starch or the crushing of soybeans to yield oil and protein meal. TVA is developing technology to process cellulosic materials to sugars for fermentation to ethanol and other chemicals in a 3.5 ton per day experimental facility. Protein is extracted from the feedstock before processing.

Serecea lespedeza is a good crop for illustrative purposes but other forage crops have similar agri-refinery potential. Serecea lespedeza can grow in relatively poor soils with possible yields of two to four tons per acre.

Fertilizer, energy, and water requirements are low. Year-round ground cover and a stand life of 15 years is possible. Protein content is about 15 percent. Preliminary crop budgets for Serecea lespedeza and other forage crops grown with traditional practices indicated possible returns from an agri-refinery operation comparable with returns from soybeans (TVA).

Residues from agricultural crops left in the fields after harvest represent millions of tons in unused biomass resources. Examples of such wastes include corn stover, wheat straw, stalks, and tree prunings and thinnings. Residues from agricultural processing are also available for biomass fuels. Fruit and vegetable waste, nut shells (almonds, walnuts, pecans and peanuts), and cotton gin trash are all biomass resources presently being used for fuel. Agricultural crop residues can be used on the farm to dry grain crops such as corn and sorghum, using portable gasifier-combustors, as well as for process heat and electricity by local industrial plants. For example, combustion of 50,000 tons of peanut hulls for process heat and electricity is planned for 1986 in Alabama. A report prepared in Alabama envisioned the use of 25 percent of that state's wheat straw residue for farm and industrial energy production by 1990 (Herz).

Livestock and Poultry Wastes

Animal wastes from livestock and poultry can be directly burned or anaerobically converted to methane gas to produce thermal or electrical energy. Direct combustion is probably the most feasible process for converting litter-based manure into energy. Litter could be burned directly or transformed into pellets for easier storage and handling and more efficient burning. Energy values from burning litter are relatively high and capital investment costs for furnace or boiler facilities are relatively low for small operations (Jones and Ogden). Anaerobic digestion is more practical for converting manure feedstocks into energy (Office of Technology Assessment, 1986). Large-scale operations may benefit by installing anaerobic digestors to produce methane from manure, for use as a heating fuel or electric generation. The slurry that remains after digestion contains most of the original nutrient value and may be applied to crop plants as fertilizer. Livestock and poultry wastes could become a major source of farm income in Georgia if conventional energy prices continue to increase (Jones and Ogden). Since transportation costs for moving bulky waste materials to central processing facilities would be very high, most use will probably be concentrated on the farm.

Forestry Crops

Wood is the largest potential source of biomass energy in Georgia. Wood from forest generally used for fuel include waste from logging operations, excess forest growth, insect-infested and diseased trees. The volume of non-commercial timber may be as much as 40 percent of total forestry inventory (Western Sun). Mills producing lumber and other wood products also generate substantial quantities of waste suitable for fuel. Only about half of the wood in a log used by a sawmill is converted to lumber, with the other half typically being waste. There is some harvesting of whole trees for fuel chips and several experiments are being conducted on growing short rotation woody crops (Badger, Roetheli and Stinson).

The major energy use for wood is direct combustion for process heat and electricity. TVA researchers are studying the process of producing ethanol or fuel alcohol from wood, but a commercially viable process has not yet been developed. The market for wood residues in Georgia consists of sales to pulp and paper mills, secondary wood product industries, agribusiness firms and trucking companies (Ames and Dunavent). Paper and lumber mills use wood residues to cogenerate electricity and useful heat. Energy intensive industries such as chemicals, petroleum, pulp and paper mills find it cost effective to generate their own electricity and use the heat by-product for space heating or to process steam for industrial use. The efficiency of a cogeneration system can approach 80 percent when all forms of waste energy are used (Orlando). Conventional steam electric systems that do not recover rejected heat have efficiencies approaching only 40 percent. The impressive efficiency rating of cogeneration inspired Congress to pass the Public Utilities Regulatory Policies Act (PURPA, 1978) which, among other things, was designed to encourage conservation of energy and efficient use of energy resources by public utilities. Regulations under PURPA require utilities to purchase all power delivered by cogenerators and small power producers at rates based on their avoided cost for this power. Utilities cannot charge discriminatorily high rates for backup power needed by biomass cogenerators. PURPA also removed most of the federal and state utility regulations from qualified cogeneration and small power production facilities.

Presently, cogeneration production in the U.S. is approximately 113,000 megawatts and it has been estimated that by the year 2000, 15 percent of the electricity generated nationwide will be cogenerated (Electric Utility Week, June 18, 1984). Georgia currently has 39 cogeneration and small power production facilities with a combined power generation capacity of approximately 600 megawatts. More than half of the total qualified capacity, as defined under PURPA, is owned by firms in the wood and paper products industry (Cole). Georgia has a tremendous potential to develop wood cogeneration when you consider that 63 percent of Georgia is forestland. Based upon 1985 inventory data, there is enough unused wood residue (cull, waste trees and sawmill residue) available to generate an additional 615 megawatts in the state at this time (Georgia Forestry Commission). In addition to utilizing unused resources, developing cogeneration could have a significant impact on employment in local communities. It has been estimated that for every 1000 dry tons of wood used per day for processing, about 150 jobs are generated from harvesting and transporting the wood. Employment and other benefits derived from increasing Georgia's biomass energy production are discussed next.

Potential Benefits

If energy is produced from resources indigenous to Georgia, more jobs and income will remain in the state. The positive economic impacts associated with increased biomass use will benefit farmers, consumers, and a wide selection of industries located in both urban and rural areas. Crop residues can be used to generate electricity for on-farm use (drying grain, heating or cooling poultry facilities, etc.), or selling it to the local power company under PURPA regulations. Growing forage crops for energy needs would increase the use of marginal land which does not generally compete with crops requiring prime farmland. Forage crops also serve as an excellent means of soil conservation by providing year-round ground cover. A greater utilization of resources in the agricultural sector will stimulate rural economies through increased input purchasing and sales. Predicting the growth of biomass energy on the farm is difficult, but some researchers have indicated that livestock and poultry wastes alone could become a billion dollar energy source for Southern farmers in the near future (Jones and Ogden).

Georgia's timber industry will probably be the largest contributor to biomass energy in the future. It is currently an $8.6 billion industry and has the infrastructure in place to develop new sources of electricity throughout the state. Paper and pulp mills are already using cogeneration systems that have many advantages over conventional systems. Cogeneration systems have smaller construction and investment costs than large centralized power stations. Cogenerating units may be brought on line in relatively short periods of time and can easily be expanded to increase capacity. Industrial users can reduce costs, particularly during peak times when energy demand is the highest. The environmental hazards are less for many cogeneration systems (Western Sun). Wood fired units may not require the sophisticated and expensive SO_2 emission control equipment needed for coal-fired boilers. Also, cogeneration could help create jobs in areas that are otherwise restricted from growth because they have exceeded air quality standards. Although the total benefit from developing biomass energy in Georgia is currently unknown, the economic opportunities appear to be promising. Alternative ways to promote energy production are presented in the next section.

Policies Promoting Biomass Energy

Federal and state governments have adopted several policies and programs designed to encourage biomass energy development. PURPA is the principal Federal law which directly addresses cogeneration and small power production. It grants "qualifying" cogenerators and small power producers the right to interconnect with the utility grid, contract for backup power at nondiscriminatory rates, and sell excess power at the utility's "avoided cost". The primary energy source for qualified small power producers must be renewable such as biomass or waste. The aggregate use of oil, natural gas, and coal may not exceed 25 percent. Each state's public service commission is responsible for determining the appropriate avoided cost rate, setting interconnection costs and manner of payment, and enforcing interconnection by utilities with cogenerators. Since PURPA was enacted, cogeneration and small power facilities has increased throughout the U.S., especially in high cost energy areas. For example, Houston companies like Dow Chemical and Diamond Shamrock expect to make billions of dollars in future years by selling electricity to a Texas utility company. The utility is currently getting about 15 percent of its total power from cogenerators. Diamond Shamrock erected a 4.5 megawatt facility in Stockton, California fueled by walnut shells. As a result, the company saves approximately one million dollars per year in energy costs (Horn). Some states are so enthused about cogeneration that they have instituted their own policies to see that it is encouraged (Markowitz).

In Georgia, most cogenerated power is produced for on-site industrial purposes. Only a small number of power producing facilities are actually interconnected with major utility grids. Two major reasons have been cited for the low participation rate in Georgia. The first is the Public Service Commission has set the avoided cost level too low to stimulate much investment in cogeneration. This cost figure is based on the fuel cost recovery rate current when purchases are made. Secondly, the Attorney General's ruling that third party financing of cogeneration facilities is illegal has seriously restricted capital investment. Raising the avoided cost level and removing the third party rule could significantly increase cogeneration production in Georgia.

In 1983 Congress directed the U.S. Department of Energy (DOE) to establish regional biomass energy programs to promote the development of biomass energy. Georgia is in the Southeastern Regional Biomass Energy Program (SERBEP) which is managed by TVA. The goal of the regional energy programs is to encourage the production and use of biomass feedstocks for fuels by the private sector through support of regionally specific biomass energy projects. Cost sharing funds and technical assistance is offered for research and development of production and conversion technologies. Interregional advisory groups assist in identifying relevant project areas and selecting projects. In most cases, the projects selected involve technologies that offer near-term commercial feasibility and emphasize modest expansions of existing technology rather than the development of new technologies. Four such projects have been funded in Georgia during the past two years and two more are expected next year. The four sponsored projects involve using wood or wood residues for energy production including a gasification unit at the Northwest Regional Hospital at Rome, Georgia. No research on animal waste or crop residue conversion has been funded through SERBEP in Georgia. Research is needed in these areas as well, to provide economic and technical information to potential producers and users of biomass energy.

The federal government also has started loan guarantee programs to reduce the risk of commercial loans. DOE guarantees loans for the construction of ethanol plants. DOE incurs a liability only if the borrowers fail to repay their commercial loans. Ten conditional loan guarantees have been approved and two plants are already in commercial operation.

The 1985 Farm Bill has several provisions related to developing biomass energy on U.S. farms. For example, USDA in concert with EPA has been asked to study mechanical problems associated with using unleaded gasoline in farm engines designed for leaded fuel. The USDA is also required to study the cost effectiveness, economic benefit and feasibility of a Strategic Ethanol Reserve (Gavett, 1986). In addition, a Special Report for the 1985 Farm Bill was prepared to assess the costs and benefits that new technologies will create in the agricultural sector (Office of Technology Assessment). Past farm programs could also have an impact on the future development of biomass energy. For example, soil conservation programs that encourage the removal of erosive crops may become more popular as energy options develop for forage production.

Considering the total federal energy program, the amount of investment related to biomass and other renewable fuels is small. According to former DOE Undersecretary Pat Collins, only 20 percent of the federal incentives are related to encouraging renewable fuels and the other 80 percent goes to traditional energy sources. In the spirit of new-federalism, states are expected to solve their own energy related problems. Georgia has taken some action to promote renewable energy in the past few years. The Georgia Forestry Commission has been very active in promoting the use of wood for energy through educational programs and has also provided money and technical assistance for research in this area. However, the overall impact of these programs has been small. On the other hand, California, Alabama, Illinois, North Carolina, and other states have reported considerable progress in their efforts to promote alternative energy sources. California has in place the State Agricultural and Forest Residue Act (SAFRUA) to establish a revolving loan fund to promote the immediate development of biomass-to-energy projects through short-term loans co-funded by private industry. Project benefits (as of 1984) from $10 million in loans provided by the state and $45 million in matching funds by private industry included $145 million in sales, $80 million in gross state income, and 1,750 jobs. Alabama has used funds from the oil/gas windfall profits tax to provide low interest loans to help finance renewable energy projects. In the Great Lakes states, there are over 32,000 people currently employed in jobs related with biomass energy. This number is expected to more than double by 1995 (Great Lakes Regional Biomass Energy Program). North Carolina has established a nonprofit energy corporation called Alternative Energy

Corporation (AEC). It is a cooperative partnership between all the state's utility organizations and the State Utilities Commission. Its major goals are to save North Carolina citizens money by increasing energy efficiency and delay the construction of costly new power plants. AEC is funded directly by ratepayer contributions from its six member organizations. The annual budget is $2.3 million, with no funds appropriated from state or federal taxes. Activities of AEC are organized around five sectors: agriculture, community, industry, residential/commercial and utility. A current project in the agricultural sector is studying whether electricity generation on North Carolina farms is profitable for farmers. This particular project is exploring the potential for farmers to use trees on their property as a source of electricity and heat. The preliminary economic analysis performed by North Carolina State University shows encouraging results. Although the study is not complete, the payback period for the most viable system has been estimated to be less than a year. Another AEC program has been developed to help local governments establish policies to reduce energy consumption in routine operations and management. In one year, this program saved over $385,170 in energy costs for 17 local governments.

State Enterprise Zones can be established to promote a broad range of economic activities including the encouragement of biomass energy development. State Enterprise Zone programs have become an effective new tool in economic development at the state and local government level. Enterprise zones are designed to create new jobs, particularly for disadvantaged workers and long-term unemployed individuals, and to promote economic revitalization in distressed areas. Under these programs, the government does not have to spend money, instead private-business activity is stimulated by easing regulations and providing tax incentives in targeted areas. Although the Reagan

Administration is in favor of this concept, and New York Representatives Jack Kemp, Republican, and Robert Garcia, Democrat, have worked hard for federal legislation; Congress has yet to pass any enterprise zone legislation. Nonetheless, 26 states have enacted such measures on their own and there are now 1,281 enterprise zones in 524 local jurisdictions across the country. One of the most attractive features of state Enterprise Zone programs is that they are a highly flexible tool which can be used in a variety of combinations. Some states designate zones as part of an industrial development strategy, others use it for commercial development or to target rural poverty. Local governments in California are looking into the possibilities of attracting specific kinds of technologies to their zones. Enterprise zone incentives such as: property, sales, motor usage, or inventory tax exemption, fixed asset or working capital loan pools, loan guarantees, unemployment insurance tax credits, and credits for hiring and training new employees have generated considerable business and employment activity (U.S. Department of Housing and Urban Development, HUD, 1986). A HUD report estimated that $2 billion in investment and 50,000 jobs have been created in state designated zones from 1982 to 1985.

Georgia has only two Enterprise Zones and the state's legislation mandates that zones can only be designated within the city of Atlanta. Opponents of Enterprise Zones argue that such programs would simply relocate business activity and drain revenue from existing areas. However, early successes and increasing numbers of Enterprise Zones nationwide indicate that they have not caused harm to local residents or other business. Georgia may be forfeiting economic opportunities by not taking full advantage of this new tool in economic development. Enterprise Zone incentive packages can be designed specifically to deal with Georgia's economic problems. For example, an industrial energy zone could be established under a set of economic incentives that promoted cogeneration fueled by biomass (e.g. crop residues or wood residues) and other complimentary activities. The energy produced could be sold to a utility company and/or used by business firms also located in the zone. Studies investigating the numerous possibilities of Enterprise Zones could open up new avenues for economic development in Georgia.

Conclusions

Technological and structural changes in energy development are likely to cause significant changes in U.S. agriculture. The Federal Government has initiated a few studies to help identify the social and economic impacts associated with emerging technologies for U.S. agriculture. In addition, legislation such as PURPA and regional programs have had some influence on energy conservation and the development of renewable energy sources. However, it is the responsibility of each state to solve its own unique energy problems. Although Georgia, relative to other states, has low power rates, there is no guarantee that this situation will continue. In fact, if state utilities continue to build huge expensive power plants such as Vogtle, Georgia may lose its favorable rate advantage. Neighboring states such as North Carolina, Alabama, and Florida who have already developed programs to increase their supplies of renewable energy may attract industries and jobs away from Georgia in the future.

Georgia must take action now to maximize the development of alternative energy resources and strengthen its economy through a rational [illegible] strategy. Many pertinent questions should be addressed before embarking on a new energy program. Research is needed to identify the economic impact on farm incomes, consumer welfare and industrial output from promoting biomass energy production. Economic tools such as sensitivity analysis can be used to help a producer decide if incorporating biomass energy into his operation is cost effective. Farm budgets could determine the economic feasibility of producing biomass energy and how this energy could be used to achieve the highest return. Potential Enterprise Zones could be modeled to assess the economic impacts on targeted and surrounding areas. Research in agriculture and other aspects of energy development can help establish a management plan capable of providing affordable, clean energy for Georgia's citizens and businesses at a reasonable price.

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PRESENTATION TO THE COMPREHENSIVE ENERGY PLANNING COMMITTEE

DECEMBER 5, 1985

BY:

BILLY LOVETT, VICE CHAIRMAN
GEORGIA PUBLIC SERVICE COMMISSION

COMMISSIONERS:
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Georgia Public Service Commission
244 WASHINGTON STREET, S.W.
ATLANTA, GEORGIA 30334

December 5, 1985

Honorable Cas Robinson, Chairman
Comprehensive Energy Planning
  Committee
State Capitol
Atlanta, Georgia 30334

Dear Mr. Chairman:

I appreciate the invitation to appear before your committee to discuss a comprehensive energy plan for Georgia. You and your committee are to be commended for this work. The Public Service Commission, in trying to develop a proactive position, is concerned about knowing the full potential of all energy resources within the State so that as the State plans for its energy future, a balanced low-cost generation mix will be available for its citizens. The Commission has embarked on a project of identifying all useable energy resources in Georgia. In addition, we will be studying cogeneration, wheeling, and transmission access.

In this presentation, I have outlined the need for a comprehensive energy plan. I would like to see Georgia take a leadership position in energy efficiency and development. As we are all aware, the federal government is cutting back in a lot of energy research and development areas. States will have to pick up the slack or we simply will not get the job done. The lack of proper energy planning could be highly detrimental to the State's economic development.

As energy costs impact every citizen, business, and industry in this State, the job of studying a least-cost planning approach becomes more and more obligatory. I hope that during these proceedings you will gain input from all sectors. There are many State agencies that are concerned with the issue including, but not limited to, Agriculture, Industry and Trade, Economic Development Council, Office of Energy Resources, Environmental Protection Division, and others.

I know you will want to give careful study to these and other options that will be presented to you. This presentation is by no means complete--some deserve further study; some are ready for enactment. I have every confidence the final product will be what is best for the citizens of Georgia as well as for future generations.

The observations I have made in this presentation are based on seven years of service with the Public Service Commission and as a member of the National Association of Regulatory Utility Commissioners' Energy Conservation Committee. The information contained herein is derived from many sources including:

Department of Energy
National Association of Regulatory
  Commissioners
Southern States Energy Board
Georgia Forestry Commission
Office of Energy Resources
American Public Power Association
Oglethorpe Power Corporation
Georgia Power Company
State of Florida Public Service
  Commission
United States Department of
  Agriculture

I pledge my cooperation and support for your efforts. If there is any way I can be of assistance, please do not hesitate to call on me or my office. I look forward to working with you.

Thank you again for this opportunity.

Sincerely,

BILLY LOVETT
Vice Chairman

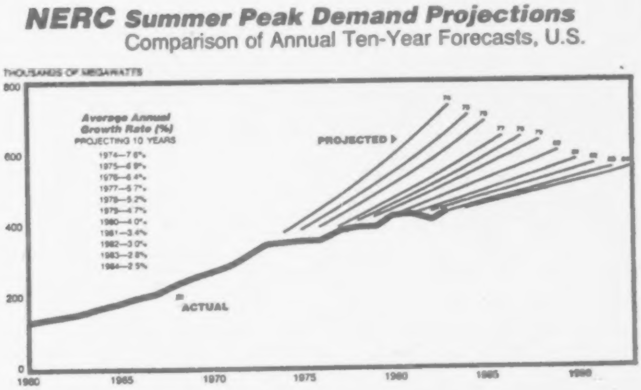
BL:cp

THE MISSION. . .A COMMON-SENSE WORKABLE BLUEPRINT TO PROVIDE REASONABLE ENERGY COSTS AND GIVE GEORGIANS CONTROL OVER THEIR ENERGY FUTURE

* promote conservation of nonrenewable energy resources;
* maximize development of alternative energy resources;
* strengthen the economy through a rational energy strategy;
* provide affordable, clean energy for Georgia's citizens and businesses at a reasonable price; and
* give Georgians control over their energy future.

INTRODUCTION

Utilities have always planned to meet the need for future adequacy of energy supplies. That used to be an easy process --draw a straight line on a graph, connecting the dots representing past energy and power, and then continue that line straight on into the future. We all know that doesn't work any more and hasn't for quite some time. Much more sophistication is needed today. The transition isn't going smoothly. Some states face overcapacity and cancellation of plants that are nearly completed. Other states face the potential need for new generating plants looming in the not-too-distant future --but they aren't as certain of the need as they once might have been.



NERC Summer Peak Demand Projections
Comparison of Annual Ten-Year Forecasts, U.S.

Most electric power forecasting groups overestimated demand growth during the past decade. The spread between their forecasts of demand growth for the decade ahead is the equivalent of more than 300 large (1,000-MW) power plants. Such uncertainty forces utility planners to build flexibility into their plans. Chart by North American Electric Reliability Council

10 FACTORS WHICH MAY INFLUENCE CAPACITY PLANNING

1. **MANAGING CUSTOMER DEMAND** - Active utility programs to influence load shape and annual load factor have become commonplace. These "demand-side" efforts may fill valleys, clip peaks or otherwise shift loads. Energy conservation techniques are also instrumental in holding down load growth. The effects of such programs are dynamic, and often hard to measure because of their relative newness. But the impact must nevertheless be factored into future generating requirements.

2. **SHORTER LEAD TIMES AND MODULARITY** - Under conditions of uncertain demand and relatively high cost of capital, exposure to risk can be lessened by meeting incremental electricity demands more quickly and in smaller chunks. Smaller facilities of standardized design can shorten lead times. Recent analyses by the Office of Technology Assessment (OTA) indicate utilities can afford smaller-scale capacity additions for up to 10 percent more per KW than large additions would cost. Furthermore, a mix of smaller facilities may offer reliability and availability advantages over large facilities. combined with "banking" of facility sites, lead times may be cut in half or more, sometimes to as few as two years.

3. **STRINGENT ENVIRONMENTAL PERFORMANCE** - Public concerns over environmental quality are here to stay, including air emissions concerns, groundwater protection, water-use restrictions, solid-waste disposal, siting, and hazardous and toxic waste handling. Looming particularly over the prospects for conventional coal generation or rehabilitation of existing power plants is the possibility of acid rain legislation, and efforts to deal with the "greenhouse effect" of CO_2 buildup in the atmosphere.

4. **INNOVATIVE/FLEXIBLE FINANCING APPROACHES** - Should the State consider the creation of an energy industrial development authority similar to that of New York, California and others? Possible functions could encompass research and development projects including development of agri/energy resources (note enclosure on agri/energy); alternative energy demonstration projects similar to Central State and Northwest General; provide low-interest loans to small power producers/cogenerators to encourage development; construction of energy/industrial parks in different sites to offer more competitive energy prices to make Georgia more attractive to large industry (auto plants, etc.) Utilities could operate plants under contract. Creation of a low-interest revolving loan fund to consumers to install cost-effective energy conservation equipment in their residences, businesses and industries. The above could have major impact on increasing supply and stabilizing demand.

5. COSTLY NUCLEAR EXPERIENCE - Nuclear power has had rough sledding in recent years. Cost overruns and the Three Mile Island accident have been difficult lessons for the nuclear industry. The impact of the nuclear experience on the willingness to embrace new generating technologies is hard to gauge, but many experts believe it has raised the threshold for industry acceptance of new technologies.

6. IMPROVED EFFICIENCIES THROUGH NEW CONVERSION CYCLES, COGENERATION AND WASTEHEAT RECOVERY - Heat rates for utility boilers steadily improved until the late 1960s. They have since levelled off or declined, partially due to the requirement for flue-gas desulfurization systems on new coal generation. Improved efficiencies were a major factor in the declining cost of electricity. To regain this trend, new conversion technologies must be demonstrated. Or, alternatively, combined heat and power production could spread fixed costs over more energy services. These desires are part of an economy-wide emphasis on doing "more with less."

7. COMMERCIALIZATION OF LOCAL, ALTERNATE ENERGY RESOURCES Concurrent with the increased price of conventional fuels has been the increased competitiveness of local energy resources such as low-head hydro, peat, lignite, biomass, municipal solid waste. Many have provided tax breaks for third parties, who have spurred development and commercialization of these resources.

8. FUEL FLEXIBILITY - Despite success in oil substitution, the taste of fuel vulnerability remains strong in the mouths of utility planners. The desire for fuel flexibility extends along two dimensions: to spread the mix of generating options and to employ multifuel capabilities. Fluidized-bed combustion, coal gasification, and combined coal/garbage systems fit into the latter category.

9. UNIT AVAILABILITY AND ABILITY TO BE DISPATCHED - System planners have always wanted generating units with high availability. However, as installed costs have increased, so has scrutiny of unit availability. Idle capacity produces no return. This concern may particularly affect the choice of pollution-control technologies for conventional coal generation. Dispatchable generation has also become a way of life for electric utilities and thus technologies that cannot be dispatched -- such as wind, photovoltaics and nonutility cogeneration -- may be severely discounted in the absence of cost-effective energy storage. by contrast, newer technologies that follow loads well or retain high efficiencies under part-load conditions should be especially favored.

10. BOOSTING LOCAL ECONOMY - Many power systems place a premium on energy options that retain jobs and dollars in the local economy. While difficult to measure, this emphasis is particularly true for small- and medium-sized communities in the states' regions where demographic trends have led to stagnating or declining populations. While conservation is the most oft-cited example of a job-retention strategy, local generation or cogeneration with local energy resources can displace energy purchases from outside the community.

THE ENERGY OPTIONS

Present-day and emerging generating options may be classified into five major categories. They are:

1. CONVENTIONAL TECHNOLOGIES - including new and rehabilitated coal plants, nuclear, large-scale hydro, combustion turbines, combined-cycle units, and diesels;
2. CONVENTIONAL TECHNOLOGIES EMPLOYING ALTERNATIVE ENERGY RESOURCES - including synthetic fuels, geothermal, wind, solar, thermal, biomass, municipal solid waste, low-head (small scale) hydro, and methane recovery;
3. COMBINED HEAT AND POWER FACILITIES (GENERALLY WITH CONVENTIONAL GENERATION) - including cogeneration, district heating and cooling, and waste-heat recovery;
4. "EMERGING" TECHNOLOGIES - including fluidized-bed combustion, fuel cells, photovoltaics, integrated gasification/combined cycle, ocean thermal energy conversion, alternative heat engines, thermionics and magnetohydrodynamics; and
5. "STORAGE" GENERATING TECHNOLOGIES - including pumped hydro, tidal power, compressed air energy storage and batteries.

THE PROBLEM . . . A DISCUSSION

Utility forecasting is complex and I'm not sure any of us could explain the entire problem. Part of the problem, though, has been that some utilities have been slow to realize a basic fact. That is, the product their customers are buying isn't the product they are selling. Utilities have been selling (and forecasting future sales for) electricity. Customers don't buy electricity -- they buy warmth when it's cold out -- cool, dry comfort when it's hot and humid outside -- hot water when it's time to take a bath -- a means to preserve their food until they need it and then a means to cook it when it's time to eat. Industrial buyers buy inputs to industrial processes and sources of moving products through the manufacturing process -- they don't buy electricity.

Whether utilities pay attention to least-cost resource planning or try to ignore it, their customers are going to adopt least-cost methods of staying warm when the weather is cold and cool when it's hot. They will, over time, find the most economical way of meeting all of their other needs, personal or industrial. Utility management who understands that customers are going to meet their needs for comfort and convenience in a variety of ways will adopt least-cost resource planning. Their planning will include a variety of options for the future besides building new power plants. Their ratepayers won't suffer the devastating economic consequences of paying for power plants that aren't needed. Others will go on in the old ways, building to serve a future need that might not be there or that may be avoidable.

As an example of the consequences of building new generation at today's costs, the last plant to come on line in Florida added about 20% to the capacity of the utility that built it. The cost of that one plant was just about equal to the company's entire existing plant in service -- the other 80%. So, while getting only a 20% boost in available capacity, rate base doubled.

That is why we are concerned about least-cost resource planning. That is why Florida's legislature, Florida's Public Service Commission, a number of other Florida agencies and most of their utilities are deeply involved in the planning, development and exploitation of non-traditional reserves that will meet customer needs. The list of non-traditional reserves includes conservation, cogeneration, renewable energy sources and emerging technologies. Many of the options can meet customer needs much more economically than building more power central station generating plants.

In 1980, the legislature passed the Florida Energy Efficiency and Conservation Act. That law gave the Public Service Commission authority to set conservation goals for all utilities in the state, whether investor-owned, municipally operated, or a rural electric cooperative. It also gave authority to enforce compliance with those conservation goals. (Section 366.80-366.85, Florida Statutes)

In 1980, the Florida legislature also amended the Electrical Power Plant Siting Act to make the Public Service Commission the exclusive forum for determining whether the need exists for building the plant. A part of the Siting Act deals specifically with the issue of least-cost resource planning, althought it doesn't call the concept by name; "In making its determination, the Commission shall take into account the need for electric system reliability and integrity, the need for adequate electricity at a reasonable cost, and whether the proposed plant is the most cost-effective alternative available. The Commission shall also expressly consider the conservation measures taken by or reasonably available to the applicant or its members which might mitigate the need for the proposed plant and other matters within its jurisdiction which it deems relevant." (Section 403.501 through 403.539, Florida Statutes)

In implementing the two Florida Statutes described, the Public Service Commission developed a separate chapter of rules in the Florida Administrative Code, Chapter 25-17. As one of those rules, a methodology was prescribed to be used to determine whether conservation actions are cost-effective. The methodology is complex, but in essence, it compares the cost of conservation or load management against the cost of the generation unit that it may potentially avoid. (Rule 25-17.08, Florida Administrative Code)

Plant costs include revenue requirements needed to pay for the plant and associated transmission and distribution facilities. Calculations include capital carrying charges, operating and maintenance expense, taxes and an equitable return, adjusted by any difference in fuel costs that may be incurred by delaying of a scheduled plant. Conservation/load management costs include costs to the utility, including incentive payments, costs to customers who participate in the program, and any other costs or benefits to society as a result of the alternative program. It will be some time before siting a new power plant is cheaper than the available alternatives. The cost-effectiveness methodology is now being analyzed with an eye toward revision to refine it based on several years' experience with it.

Not only conservation, load management and other alternatives are available, but Florida has statutory authority to require transfer of energy among utilities. "To assure efficient and reliable operation of a State energy grid, the Commission shall have the power to require any electric utility to transmit electrical energy over its transmission lines from one utility to another or as part of the total energy supply of the entire grid. . ." 366.055(3), Florida Statutes.

Florida has held annual workshops for the past several years to review utility planning. Each spring, they hold workshops to review utility generation expansion plans and transmission planning. Each fall, they hold conservation planning and forecasting workshops to review the implementation of conservation, load-management and cogeneration and to review the forecasts of all Florida's electric utilities. This year, they combined them into a single hearing, rather than two workshops. Bringing both pieces of this process together into one, single forum tends to underscore the belief that demand-side planning and supply-side planning are just two halves of least-cost resource planning. In the planning process, they look, not only at the needs of the individual utilities in isolation, but instead, look at planning as a statewide process.

Some utilities were already embracing the concept of least-cost resource planning prior to the Florida Public Service Commission receiving its broadened statutory authority in 1980. Others were more conventional in their thinking, planning ahead to their next power plant.

Among the most exciting things about conservation in Florida has been the acceptance of conservation as a viable alternative to building new power plants. Some have shown less enthusiasm for conservation than others. Overall, though, conservation is a major thrust of Florida's utilities. This whole area is one where the best interests of the ratepayers and best interests of the stockholders are in concert. Interestingly, the cost-effectiveness methodology mentioned earlier shows clearly that benefits flow to all parties, ratepayers of all classes and to the stockholders. The least-cost concept makes good economic sense, and it is hard to argue with it.

Investor-owned utilities, gas as well as electric, are allowed to recover their costs for conservation almost concurrently. Each six months, at hearings before the Commission, utilities project their conservation expenditures for the next six months, and are allowed to recover them through a factor added to the customers' bills. At the same hearings, the actual expenditures of the preceding six months are reviewed to ensure they meet Florida's criteria. In essence, the utilities face almost no regulatory lag in recovery of any of the money they spend on conservation. In Florida, the five largest investor-owned electric utilities and the five largest natural gas utilities are currently spending and recovering over $100 million per year. It is believed this rapid recovery of funds also helps conservation.

Florida was among the first and most aggressive states to get seriously involved in conservation. One of the biggest problems faced was a lack of information. The Georgia Public Service Commission has been facing a similar problem. We have been asking questions since before 1980, and some of the answers still aren't clear. For example:

1. What alternative technologies are available or are becoming available? What is their cost on a KW avoided basis? We have found that information, particularly about cost of alternatives is sparse and often contested by various parties.

2. How much reduction in KW (demand) or in KWh (energy) can reasonably be expected from a particular conservation measure? Engineering estimates of savings expected due to increased efficiencies of equipment, in some cases, are confounded by the human factor. With more efficient equipment, people's operating costs went down, they began to increase their comfort level, and that cut into the expected savings. The magnitude of this "rebound effect" is still not well understood.

3. What is the status of energy using end-use equipment and how is it changing over time? Should we conduct a biennial survey or residential customer end-use appliance stocks to track the changes in efficiency?

There are a number of ways the Department of Energy could be very helpful to the states in promoting least-cost resource planning. They all relate to information transfer (or technology transfer).

NARUC suggests five databases:

1. Technology/Cost-Curve database: It would be very helpful to us and perhaps even more so to states that are not as deeply involved in least-cost resource planning as Florida to have improved confidence in information about technology providing alternatives to building central station electric generators. Sound estimates of the timing of the commercial feasibility of various alternative technologies would allow better planning. Better estimates of the costs of alternatives would allow state commissions and individual utilities to make better decisions on the economics of alternatives versus building more plants.

2. Stocks and Flows database: Information gathered from individual state efforts, such as NARUC's End-Use Customer Survey would be helpful to others who are doing or contemplating similar projects. The interchange of information could be greatly assisted by DOE through maintenance of databases. Perhaps DOE could even develop databases that are accessible as electronic bulletin boards where interested parties can freely interchange information using micro-computers with communications software.

3. Monitoring, Analysis and Quality Control database: Knowing more about the magnitude of the "rebound effect" would be helpful to commissions and utilities in judging the impact of various alternative technologies. This would tie closely into the information in the two previously mentioned databases.

4. Policies and Information database: The states that have well-established programs in this area receive requests very frequently from states that are becoming more interested as time goes on. A centralized source that provided an easily accessible database for the exchange of orders. State statutes and administrative codes (implementation rules) would help spur participation among all states and keep us all from reinventing the wheel every time we need something new. This type of database would also be an excellent example of an application well-fitted for electronic bulletin board.

5. Methodology Handbook: DOE review of existing state and utility planning tools and compilation of the materials in handbook form would be very helpful to many state commissions, their staffs and the utilities involved in this whole area. Commissions new to the area would be able to benefit from those who have already come far down the road. Regional seminars based upon such a handbook would be very helpful to state commissions and utilities with limited budgets.

THE SOLUTION . . . RECOMMENDATIONS

Our goal should be to provide a mechanism for reaching an agreement among all affected parties, including utilities, state regulators, and consumers on the desired level of electric service for the State and the means for providing such service including a mechanism for providing reasonable assurance of the appropriate recovery of cost and investments needed to accomplish such an objective.

1. Certification. A stringent certification system for proposed construction projects. Rule R8-42 of the North Carolina Public Utility Commission requires that preliminary plans for additional generating capacity be filed with the PUC not less than 120 days prior to the actual application for Certificat of Public Convenience and Necessity. Among the 10 items of information that must be filed, three were most interesting:

1. A statement of the need for the facility, including information on loads and generating capability.
2. A statement of estimated cost information, including plans and related transmission capital costs (initial core costs for nuclear units); all operating expenses by categories, including fuel costs and total generating cost per net KWH at plant; and information concerning capacity factor, heat rate and plant service life; also the comparative cost, including related transmission cost, of other final alternatives considered.
3. A schedule showing the anticipated beginning dates for construction testing and commercial operation of the generating facility.

In addition, the applicant must file "an estimate of construction costs in such detail as the Commission may require." Before granting a certificate, the commission must hold at least one public hearing and approve the estimated cost of construction. The PUC must also find that the facility "will be consistent with the Commission's plan for expansion of electric generating capacity."

The degree of involvement by the state PUC in the up-front decision-making on utility construction projects is felt to be highly beneficial. It not only protects the interest of the ratepayers by preventing overbuilding of generating capacity, but should also tend to cause the PUC to take some share of the responsibility when a project must be cancelled. It should be noted, however, that PUCs typically have less information available as a basis for these decisions and often must rely on information from the utility involved. This could be corrected.

2. Least Cost Options. When considering an application for a Certificate of Public Convenience and Necessity, North Carolina Statutes, Chapter 62, §62-110.1, requires the commission to investigate the applicant's analysis of least-cost alternatives, including "interchange of power, pooling of plant, purchase of power and other methods for providing reliable, efficient and economical electric generating capacity."

When considering least-cost alternatives, the GPSC also should require an applicant to investigate such options as conservation, load management and cogeneration.

Load management is already a way of life for many utilities. It is a far cheaper alternative than construction of new capacity. Here again, however, it should be remembered that much of the total potential has been achieved by some utilities and it will not always be an answer.

There is a tremendous potential for cogeneration in several regions of the country. Houston Lighting & Power Company recently added 350 MW of capacity without investing a cent but rather by signing a contract. The criteria of the North Carolina statutes requires that alternatives provide reliable, efficient and economical electricity. In some cases cogenerated power may be neither reliable ror economical. This is not to say that cogeneration is not an alternative. Certainly, there is a place for cogeneration in the energy future of this country, and we are likely to see more and more successful projects. Regulators should, however, recognize the disadvantages of cogeneration and weigh them against the benefits.

3. Annual Review of Power Plant Construction. Once construction begins, the PUC should continually review the status of construction and require the utility to submit an annual progress report and any changes in the estimated cost of construction. The annual review should allow a decision being made on the prudency of continuing the construction project.

4. Power to Halt Construction. The PUC should have the authority to cause a utility to hault construction either if the cost of the facility becomes too excessive or if the need for the plant can no longer be justified. Such a decision, however, can have severe consequences for the utility, its investors and ratepayers. The cancelled plant must still be paid for. If the regulators should share some responsibility for up-front decision making for power plant construction, that responsibility must extend to a decision to cancel.

FORECASTING NEED FOR POWER

Agreement on a reasonable forecasted range of future power requirements is key to obtaining agreement on individual construction projects. A process whereby all involved parties are able to participate in the development of a reasonable forecast should be implemented.

It is suggested that each regulated utility be required to develop and submit to the PUC a 10-year forecast on an annual basis and a 20-year forecast on a biennial basis. These forecasts would be made available to the PSC staff or Consumers' Utility Counsel for the purposes of making independent forecasts. The various forecasts would then be reconciled by the PSC in a manner determined by the Commission. Whether or not public hearings are held on the forecast would be a matter left to the Commission.

The key point here is that more than one independent forecast is developed and presented to the state regulatory body. Having two or more alternative, independently-produced forecasts which must be reconciled by the regulatory body is more likely to result in a forecasted range of future power requirements, and forecasting assumptions, that can be agreed upon by all parties.

A number of states, most recently Indiana, have charged an independent commission or authority with either developing a statewide or regional forecast or producing a methodology for forecasting. The commission or authority must consult with all classes of consumers and the utilities. This approach places the onus on the state to produce a forecast of future power requirements and gives both the regulatory body and the utilities a guide for planning power plant construction. Depending on the process chosen, it could also allow the opportunity for all involved parties to participate and have input to the methodology and assumptions used to develop the forecast.

The importance of agreement seems to outweigh the actual forecast. Given the history of forecasting need for power, the one constant is that any forecast developed will prove to be inaccurate. However, if the forecast used is agreed to be a reasonable one by all involved parties, perhaps much of the often acrimonious debate over individual construction projects would be eliminated.

There has been extensive discussions about linking a state's economic development goals and the forecast of future power requirements. If a state is actively recruiting energy-intensive industry, then the possibility of such industry locating in the state should be reflected in the forecast of future power requirements. Whatever the method used to develop the forecast in a given state, the state's economic development agency should be involved.

FINANCING POWER PLANT CONSTRUCTION

Because of a variety of factors, public utilities have virtually stopped planning the construction of additional generating capacity to meet future demand. A number of projects are underway and some, though not all, will be completed. The growth in demand for the past two years and the first half of 1985 would indicate that the trend is toward significantly higher growth in demand than was forecasted as late as last year. Additional capacity will be needed and, given the construction lead times for major facilities, we must make planning decisions relatively soon.

Commitments to future construction ceased when the risks became too great for a utility company to accept. With price tags of $2-4 billion for a major coal-fired plant with required environmental modifications, and $4-6 billion for a nuclear plant with construction spread over from 7-15 years, and with no certainty that a return on investment can be realized, the decision not to build is an easy one to make. It is clear, however, that adequate supplies of electricity must be available in the future or we will sacrifice any opportunity for further economic development.

Large scale power plants with price tags in the $2-6 billion range are not financable in today's environment. Without some restructuring of the regulatory and statutory systems it is unlikely that investors or lenders will allow their funds to be frozen for a period in excess of 10 years without adequate assurance of repayment. We can no longer assume that a utility company with a net worth of X will be financed to build a plant costing 4 or 5 times X with a completion date more than 10 years in the future.

1. Construction Work in Progress. Perhaps the longest running debate in the arena of electricity policy involves construction work in progress (CWIP). The benefits of construction work in progress in the rate base offset are clear and have been delineated many times. CWIP can be a valuable regulatory tool if employed on a case-by-case basis.

A major concern of all involved parties is what is commonly known as rate shock. When a large facility is completed and goes into operation the effect on the rates paid by consumers can be substantial. Virtual doubling of rates can occur when a nuclear power plant is placed in the rate base of relatively small or medium-sized utilities. The inclusion of CWIP in the rate base could diminish and, in some instances, eliminate the impact of rate shock; but inclusion of CWIP is justified only after a stringent prudency test has been successfully applied. However, most states use CWIP as a means for improving the financial position of a troubled utility company.

2. Plant Cancellations and Recovery of Cost. One of the most difficult problems that has confronted regulatory bodies and utility companies alike over the past decade has been the cancellation of construction projects after substantial funds have been expended. The inability to recover costs is a major disincentive to the construction of generating capacity projected to be needed in the future. If a strong state regulatory program is in place, there will be some mechanism whereby the state will concur in the projected need for a facility. In most states this takes place through a certification process. The granting of a certificate is evidence that the state regulatory body finds the utility company's plans to build to be prudent. The problem lies in the length of time necessary to construct a major generating facility. With construction times from seven to 15 years, the time required to build a generating facility likely will exceed the length of office of the regulators granting the certificate.

In our system of government there are no guarantees that the new regulator will agree with the decisions of the outgoing regulator. In addition, economic conditions can vary widely over a very short period of years and demand for electric power can increase or decrease rapidly. A prudent decision made in 1975 may not seem prudent in 1985.

A utility company should be allowed to recover any and all prudently incurred costs. The manner of recovery will be determined by the state regulatory body. Imprudently incurred costs should be borne by the company's shareholders. The management and shareholders of a company should not be penalized for making a decision based on the best available data, and concurred in by the state regulators, only to fall victim to changing conditions beyond their control.

This would give utilities the assurance that prudent costs will be recovered. It allows the regulators to retain the degree of flexibility needed to determine the manner of recovery, including the number of years over which the investment will be amortized and whether or not a return on investment will be allowed, and to determine prudence. If costs are agreed to have been prudently incurred, there should be no question as to the ability of the company to recover.

The provisions of the Indiana law guarantee both recovery and return on investment in cancelled plant if the PSC has concurred in the construction program up to the time it was necessary to cancel the project. For a state government to adopt such a stance is a recognition of the state's participation in the decisions leading to initiating construction and continuing the project.

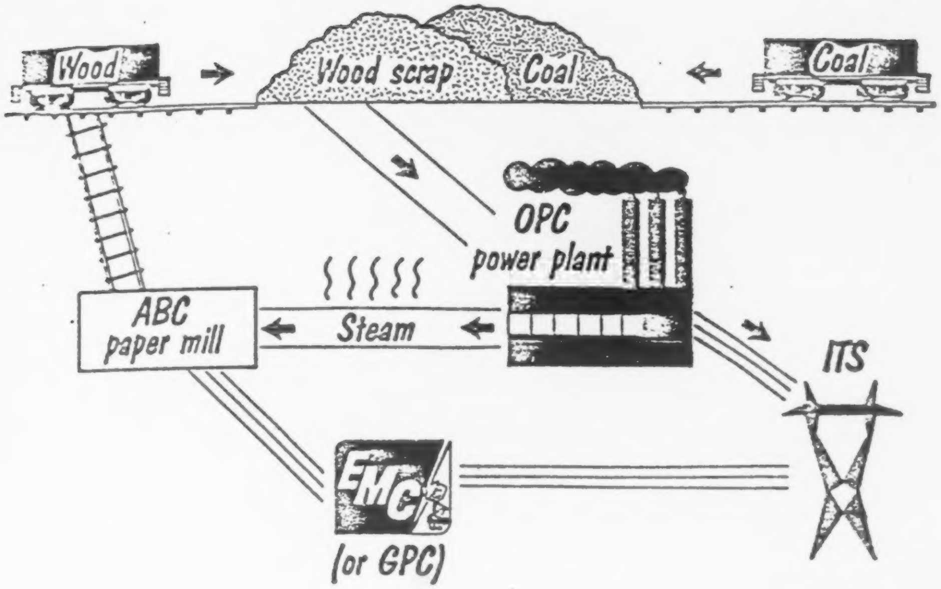
Implementation of this set of recommendations would, in my opinion, go far toward resolving fundamental problems. The development of a stringent yet fair system of regulation, applied consistently over time, would gradually restore the faith lost by the financial community, the utilities and many consumers of electric power. The type of regulatory system outlined provides safeguards to both the companies and their customers. It shares the risk more equitably between ratepayers and shareholders.

Major Points—Supply Options

Power costs in future years will be lower if OPC can confirm alternative supply options by 1986 rather than build large centralized plants

Sales of OPC excess power to other utilities can lower power costs

Cogeneration



Cogeneration

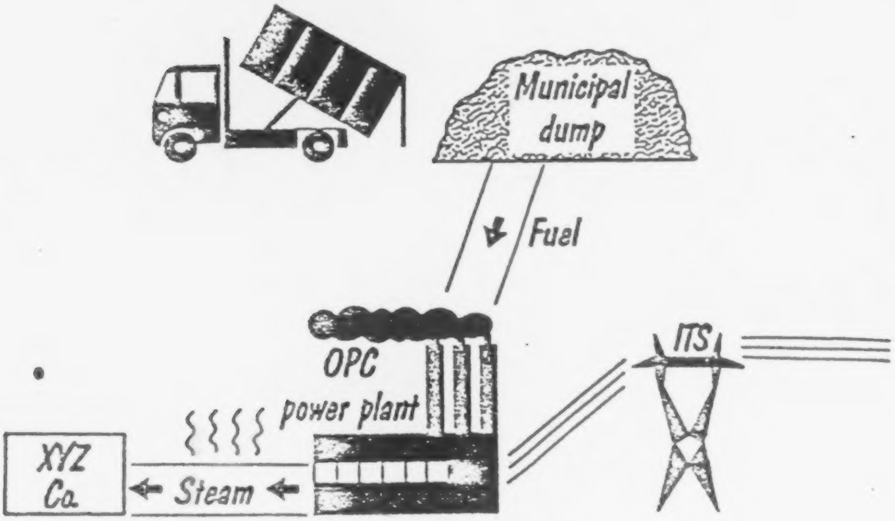
Simultaneous production of steam for electricity generation and industrial processes

Cogeneration Potential (MW)

Paper	834
Chemical	160
Textile	73
Other	163
Total	1230

- It is more efficient to produce steam and electricity in a single plant.
- Steam sales appear to be very profitable because most industries currently use oil to produce steam.
- Profits from steam sales were used to reduce wholesale power costs.
- Since the steam sales are the driving force behind the savings, this is attractive even at existing industrial plants served by GPC.
- The cogeneration potential was determined in the alternative energy study.
- Recommendations for cogeneration study were made in the 1980 Generation Expansion Plan.
- The cogeneration potential included existing OPC industrial customers and projected new industrial cogenerators over the next 10 years.

Municipal Solid Waste


Municipal dump
Fuel
OPC power plant
ITS
XYZ Co.
Steam

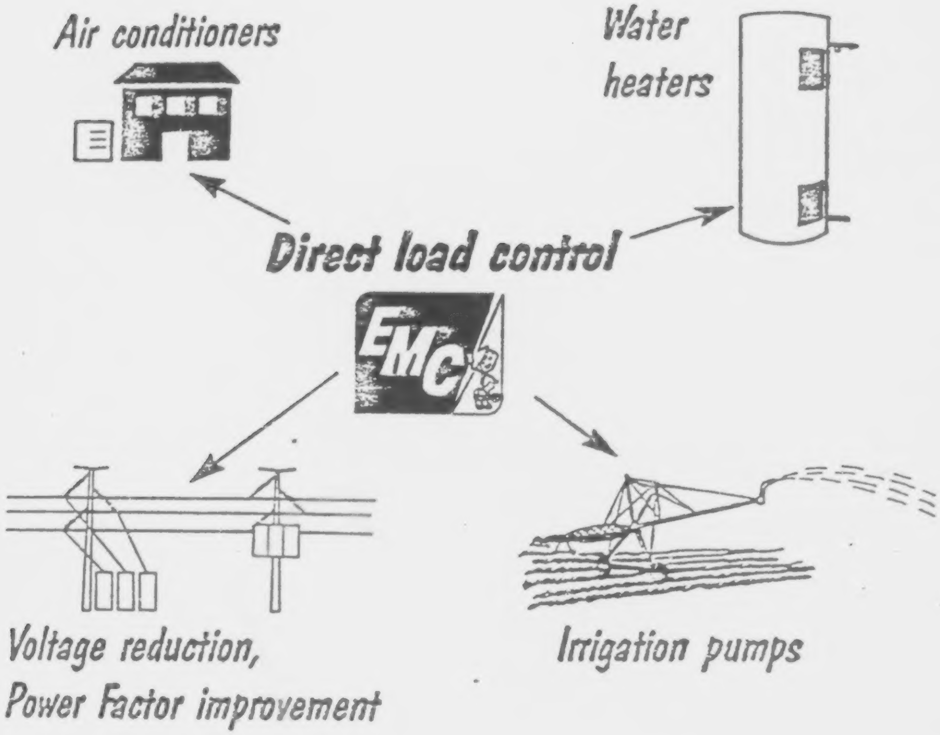
Municipal Solid Waste

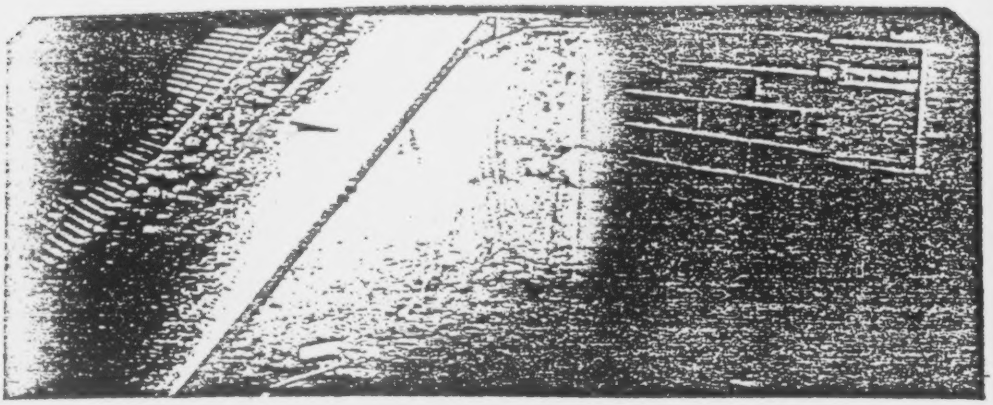
Use of municipal solid waste (trash and garbage) as fuel supply for a utility boiler

Municipal Solid Waste

25 MW in 1989

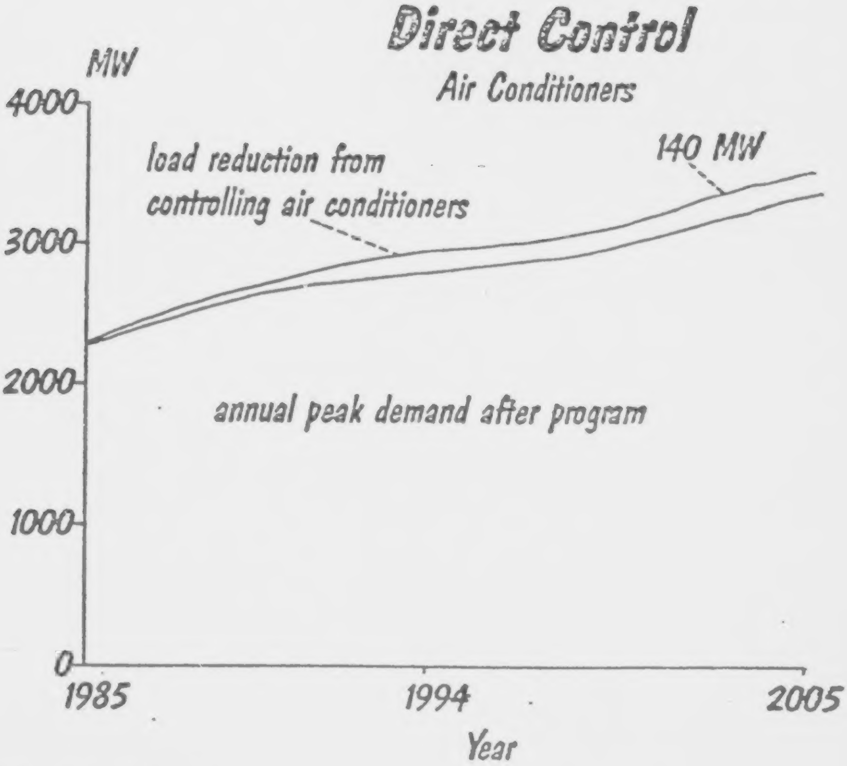
- The alternative energy study recommended by the 1980 Generation Expansion Plan showed a total potential of about 100 MW.
- This assumes OPC can produce both steam and electricity.
- Industrial cooperation is needed in the form of a 10 to 15 year contract.
- All 25 MW is not necessarily at a single plant.


Air conditioners
Water heaters
Direct load control
EMC
Voltage reduction,
Power Factor improvement
Irrigation pumps



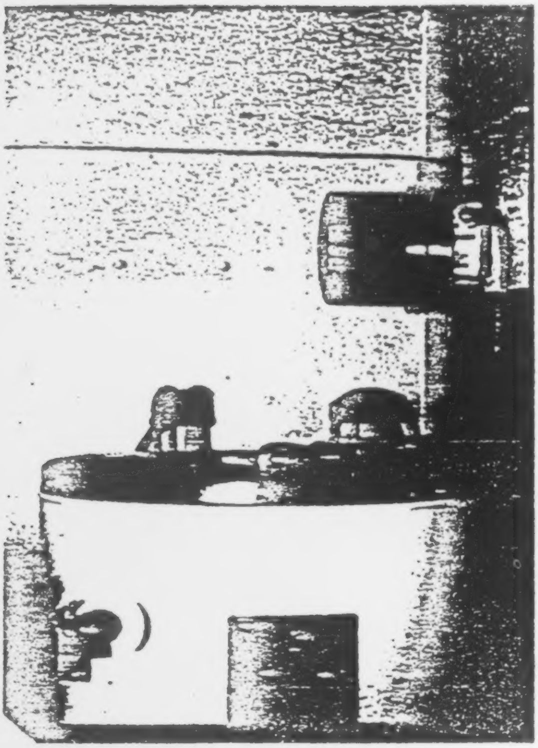
Direct Control— Air Conditioner

- 140 MW in 1994
- 12,700 new households per year
- 1.1 KW per switch



Direct control—air conditioners

1. Achieved by controlling additional units
2. Phase in over 10 years, starting in 1985.
3. Reduce projected peak load by 140 MW in 1994.



Direct Control – Water Heaters

- 140 MW in 1994
- 28,000 installations per year
- 0.5 kW per switch

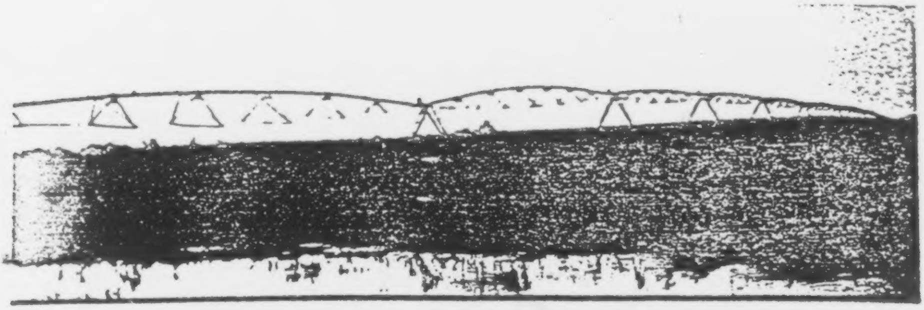
Direct control—water heater

1. *Achieved by controlling additional water heaters*
2. *Phase in over 10 years, starting in 1985.*
3. *Reduce projected peak load by 140 MW in 1994.*

Direct Control—Water Heaters (140 MW)

	OPC Oglethorpe Power	REA Consumer	EMC Average County EMC
Short term savings $	–	–	–
Long term savings $	545,000,000 (75)	357 (75)	8,000,000 (75)

- Short term savings are negligible because the cptions is not being phased in until the beginning of 1985, therefore, full benefits are not realized in the first five years.
- Long term savings are $8,000,000 for an average EMC.



Direct Control–Irrigation Pumps

- 60 MW in 1994
- 189 Pumps per year
- 32 kW per pump

Direct control—irrigation pumps

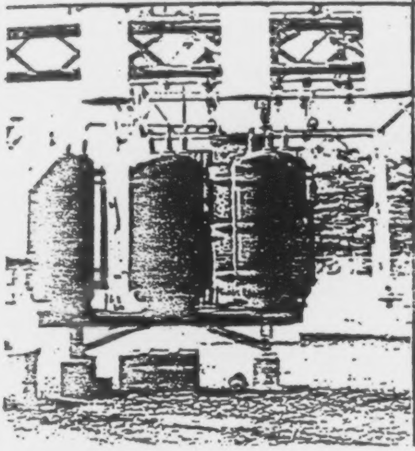
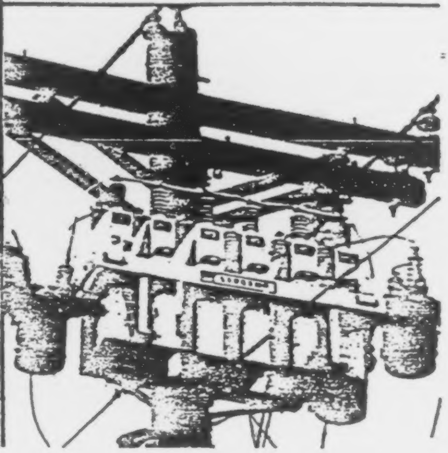
1. Achieved by controlling additional pumps
2. Phase in over 10 years, starting in 1985.
3. Reduce projected peak load by 60 MW in 1994.

Direct Control—Irrigation Pumps (60MW)

	OPC Oglethorpe Power	RSA Consumer	American County EMC
Short term savings $	–	–	–
Long term savings $	331,000,000 (PV)	383 (PV)	8,000,000 (PV)

- Short term savings are negligible because option is not being phased in until the beginning of 1985, therefore, full benefits are not realized in the first five years.
- Long term savings are $8,000,000 for an average EMC.

Direct Control–Voltage Reduction and Power Factor Improvement

50 MW in 1994	Improve Power Factor To 96%
	

Direct Control—voltage reduction

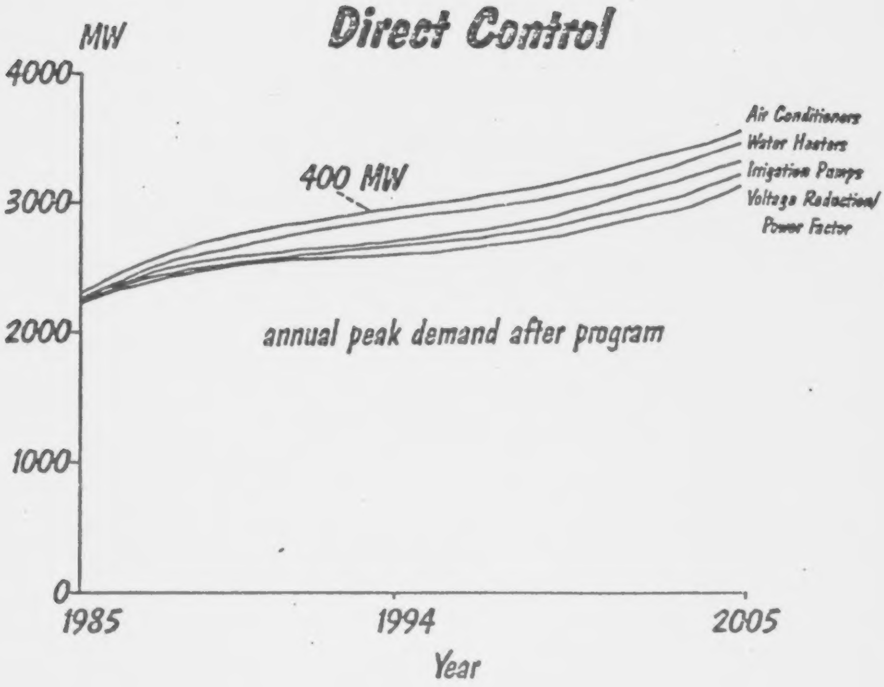
1. Achieved by EMCs reducing distribution voltage by 4 volts during selected peak hours by 1994
2. Phase in increase over 10 years, starting in 1985.
3. Reduce projected peak load by 50 MW in 1994.

Direct Control—Voltage Reduction (50MW)

	OPC Oglethorpe Power	REA Consumer	American County EMC
Short term savings $	–	–	–
Long term savings $	179,000,000	23	5,000,000

Power Factor Improvement 96 %

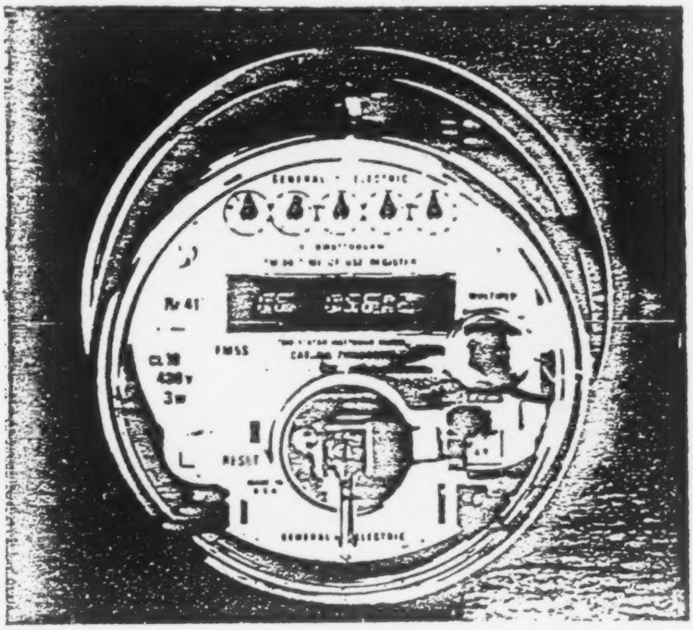
	OPC Oglethorpe Power	REA Consumer	American County EMC
Short term savings $	–	–	–
Long term savings $	35,000,000	33	1,000,000



Direct Control

Price Signals–Time of Day Rates

- On–Peak 12¢/kWh
- Off–Peak 3¢/kWh



Time of day rates

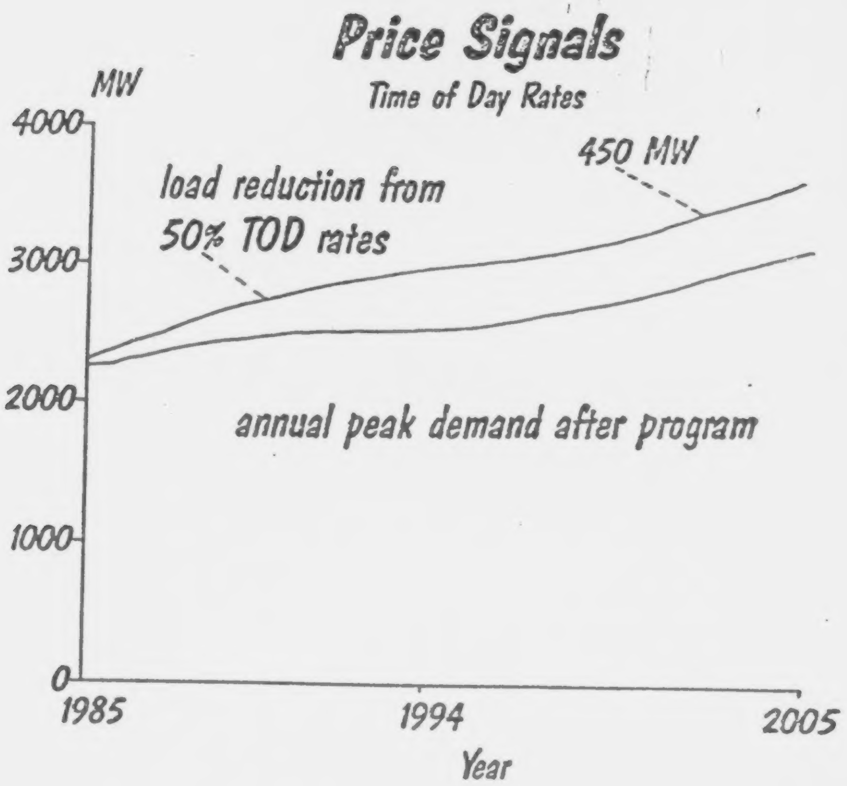
1. Implement time of day rates for 50% of residential consumers by 1994.
2. Phase in over 10 years, starting in 1985.
3. Reduce projected peak load by 450 MW in 1994.

Everyone in Georgia has been purchasing a utility service under time-of-day rates for decades—

Long-distance telephone service

Price Signals

	Time of Day Rates (450 MW)		
	OPC Oglethorpe Power	REA Consumer	EMC American County EMC
Short term savings $	49,000,000 (2%)	19 (–)	– (–)
Long term savings $	2,000,000,000 (5%)	905 (2%)	20,000,000 (2%)

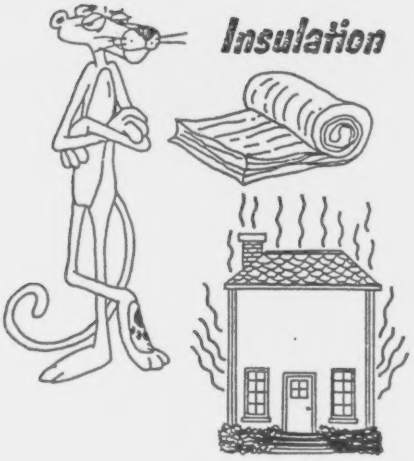


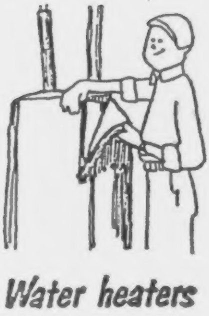
- The option would be phased in in early 1985, so the EMC would be responsible for the initial cost of implementation.

- Short term savings are $49,000,000 for OPC.

- Short term savings are negligible for an average EMC and an average consumer.

- Long term savings are $20,000,000 for an average EMC.





Insulation—home

1. Increase ceiling insulation to equivalent of 12 inch fiberglas and weatherstrip doors and window in 60% of eligible households by 1994
2. Phase in program over 10 years, starting in 1985.
3. Reduce projected peak by 240 MW in 1994

Insulation home

Benefit/cost assumes:

EMC offers a 4 year interest-free loan

Insulation—Home (240 MW)

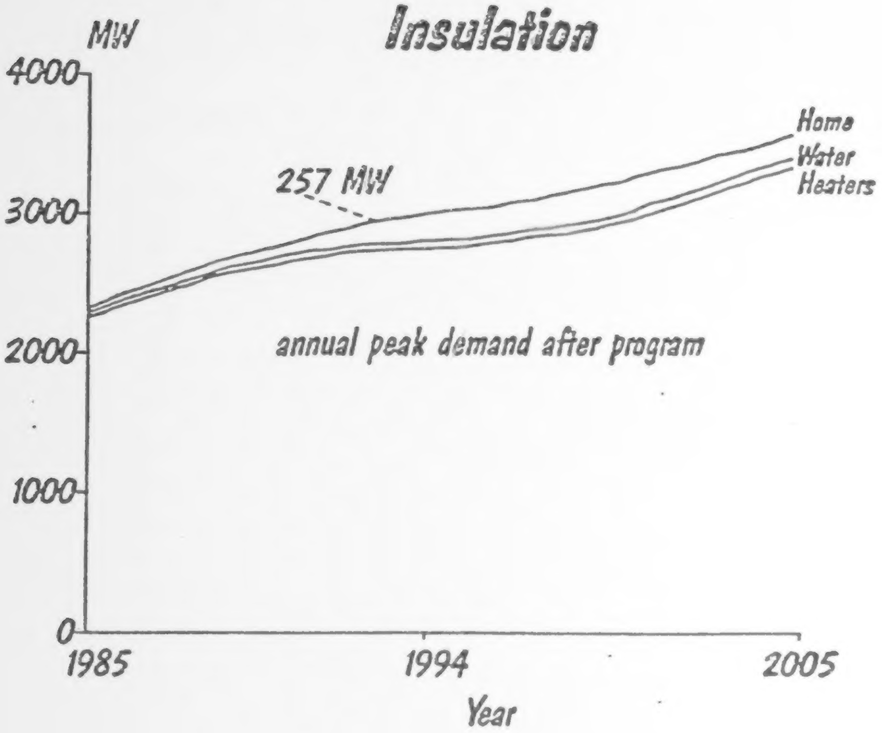
	OPC Oglethorpe Power	REA Consumer	American County EMC
Short term savings $	40,000,000 (2%)	40 (2%)	1,000,000 (2%)
Long term savings $	1,859,000,000 (5%)	1690 (3%)	37,000,000 (4%)

Insulation—water heaters

1. Install equivalent of 4 inch fiberglas insulation wrap on 75% of electric water heaters
2. Phase in program over 10 years, 1985–1994
3. Reduce projected peak by 17 MW in 1994

Insulation—Water Heaters (17 MW)

	OPC Oglethorpe Power	REA Consumer	American County EMC
Short term savings $	17,000,000	25	—
Long term savings $	392,000,000 (2%)	435 (2%)	9,000,000 (2%)



- Insulation is the only demand option studied that has significant short term savings.

- Long term savings are $46,000,000 for an average EMC.

Peak Load Impacts in 1994

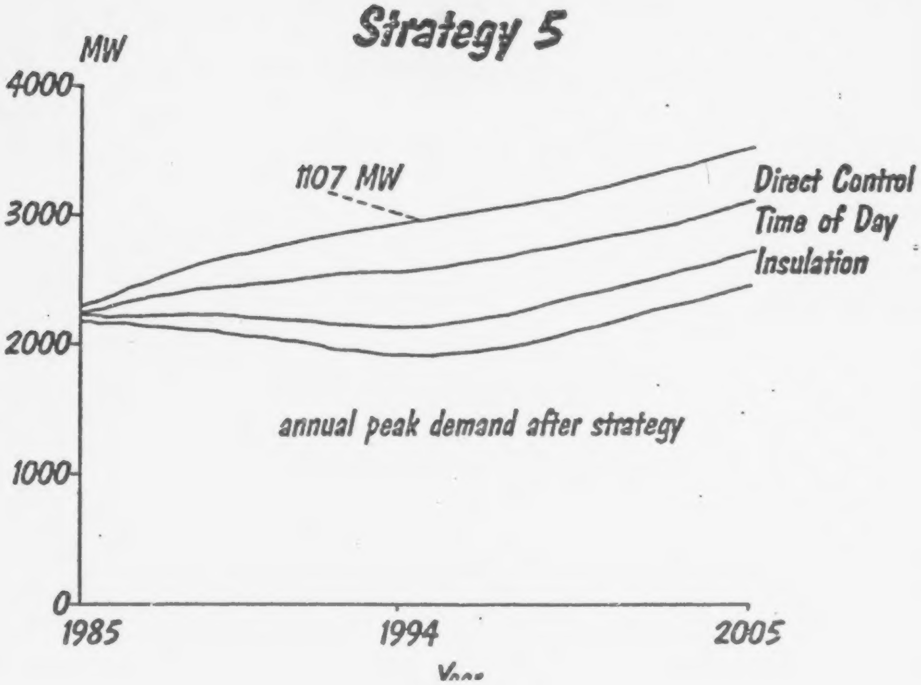
	Moderate
Direct Control	200 MW
T-O-D Rates	135
Home insulation	118
Water heater insulation	15
	468 MW

Peak Load Impacts in 1994

	Aggressive
Direct Control	400 MW
T-O-D Rates	450
Home insulation	240
Water heater insulation	17
	1107 MW

Peak Load Impacts in 1994

	Moderate	Aggressive	Potential
Direct Control	200 MW	400 MW	575 MW
T-O-D Rates	135	450	750
Home insulation	113	240	400
Water heater insulation	15	17	25
	463 MW	1107 MW	1750 MW


Strategy 5
MW
4000
3000
2000
1000
0
1107 MW
Direct Control
Time of Day
Insulation
annual peak demand after strategy
1985
1994
2005

Managing the Transition State for Energy Strategic Planning

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Eastman Kodak Company

CORPORATE ENERGY CONSERVATION PROGRAMS HAVE MADE SUBSTANTIAL gains in reducing energy consumption during the last decade. The energy conservation effort reduced excessive lighting levels, lowered thermostats, plugged leaks, and added insulation. These responses to survive the mid-1970's global energy uncertainties were made in a crisis atmosphere.[1,2]

Now, a transition is being made: from *energy conservation* to *energy strategic planning.* Energy specialists, primarily engineers, must adopt new (to them) managerial techniques, if the abundant opportunities to increase energy efficiencies are to be shaped and given life.

These opportunities involve major process improvements (in the case of industry) and the application of proven technologies. The challenge for the next decade is to balance the implementation of these opportunities with successful tuning of operations and maintenance projects requiring small capital investments.

To maximize the cost-effective benefits from these opportunities requires a total energy management program. An effective energy management program is an integral part of day-to-day business management and strategic business planning. This article discusses some of the steps needed to chart a course for successfully implementing energy strategic planning.

Energy Strategic Planning

Energy strategic planning is the clear vision of energy management over the long term. The future picture could include these components:

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- Executive Summary
- Situation Analysis
- Energy Requirements and Costs
- Issues, Objectives, and Strategies
- Action Programs
- Plan Results
- Sensitivities and Assumptions[3]

Critical Success Factors

Successful energy management programs are an integral part of the day-to-day business management and long-range strategic planning. We will discuss a few critical success factors that are essential to managing a successful energy management program.[4,5]

These critical success factors are

- Energy Policy Statement
- Realistic Energy Goals
- Interactive Energy Planning

Energy Policy Statement

The Energy Policy Statement provides the focal point for an effective integrated energy management program. This broad policy statement creates identity, enables all employees to participate in greater challenges, builds consensus, and builds commitment. Management must visibly support the policy and communicate the policy down to lowest level "where the action is."[6,7]

The energy policy statement could include the following elements:

- Incorporate and maintain effective energy management into the day-to-day business management and long-range business planning.
- Identify and implement opportunities for cost-effective profit improvement and energy-reducing product quality improvement opportunities.
- Incorporate cost-effective energy management opportunities in all phases of process and product development.
- Design new or modified equipment and facilities for cost-effective minimum energy utilization while maintaining product and quality of work life.

- Commission all new and retrofitted systems to insure cost-effective performance.
- Promote awareness and encourage proactive participation in energy management by all employees.
- Maintain energy management accomplishments.
- Maintain expertise in new energy technologies and encourage their adoption when proven reliable and cost-effective.

The current oil glut and relatively stable energy costs have reduced the visible incentive to actively commit resources to energy management. When you improve product quality, you improve productivity. In fact, achieving these gains typically increases energy efficiency.

Realistic Energy Goals

Effective energy goals provide more than direction setting and performance measurement for organization.[8,9] They are vital to

- *Establishing and maintaining freedom of action*—People who share common purposes can manage their actions with minimum coordination from staff groups.
- *People morale*—In a "high morale" organization, people accept a sense of common purpose and intensely share common energy performance goals.
- *Timely problem sensing*—Energy goals help define problems and opportunities leading to creative problem solving and cost-effective results.

The goal-setting process starts with a few broad goals. Each manufacturing organization would propose its goals using an employee consensus building process. The energy goals should be realistic, but challenging, measurable, and communicated to the lowest possible level.

Interactive Energy Planning

Interactive planning directs the energy management community to gain control of the future to effectively implement energy policy and achieve energy goals. First, the energy management planner strives to do better in the future than the best currently perceived effort—to "idealize."[10,11] The participative process allows the participants to understand their organization and its environment in order to provide the stakeholders with the opportunities to improve the overall performance of the energy management program.

Second, the energy management planner believes plans are based on assumptions, not forecasts. Since the future is largely unpredictable, organizational design should be adaptive to changing internal and external pressures.

Third, the energy management planner focuses on simultaneous and interdependent planning for the energy part of an organization, at every level.

The results of this interactive planning process show that effective managing of energy goals is important, allow members of an organization to have adequate freedom and control of their direction, and allow sharing of common performance goals. The interactive planning process develops the function (tasks and responsibilities) and form (organization) of an effective energy management program.

The process identifies the steps to be taken toward the vision of energy strategic planning. Some of the critical steps are to establish a well-defined organizational framework including roles and responsibilities and to implement performance measurement, monitoring and feedback.

Organizational Framework

An effective energy management program including strategic planning must have a strong sense of commitment, from top to bottom. An energy policy committee, chaired by a senior management person, is the visible symbol to provide proactive guidance and leadership, communicate clear expectations, and show support. Membership would be determined by the individual plant needs but could include production, maintenance engineers, facilities, and purchasing management.

An effective energy management program depends on the line organization's commitment to success. Those stakeholders must take the responsibility for actions and outcomes.[12] The organizational energy coordinators should operate in an integrative and participative team environment involving production, maintenance, and engineering personnel and consultants. This team effort builds ownership: commitment and trust in the workplace to implement and maintain an effective energy management program.

Supervisors, including organization management, should also communicate their expectations and recognize and reward cost-effective energy management programs. One visible way is MBWA—Management By Walking About.[13]

It opens two-way, informal communication and provides an environment in which to convey positive reinforcement to the workers.

The energy management group provides the consulting, helping, and coordinating roles for effective energy management programs. The group's objective is to have the energy and process management expertise needed to assist production organizations in improving and maintaining process and equipment performance. This results in product quality improvement and product cost reduction. The consultant brings to the client technical skills, interpersonal skills, and consulting skills.

These three skills increase the potential for successfully implementing and maintaining the identified opportunity. The consultant has a collaborative role working in joint problem-solving efforts with the client, establishing expectations and roles of the client and the consultant, establishing deliverables, and providing feedback.

The Energy Council membership includes the plant organizational energy coordinators and the supervisor of the energy management group. This committee shares ideas and accomplishments, identifies needs and opportunities, develops energy coordinating training programs, sets performance expectations and goals, etc. The overarching goal is to be the best in managing energy at each production level while improving product quality and reducing product cost.

The key link is the production organization energy coordinator, acting as leader for his division and department energy coordinators. We feel the most successful energy management programs are managed at the lowest possible level ("where the data are").

Each production organization is responsible for monitoring energy efficiency improvement performance, identifying and implementing opportunities, and documenting results. The quantitative data must be real and credible and must accurately represent the energy usage and production output. Performance indices correlated to cost savings increase employee awareness and result in higher energy management performance.

Feedback and corrective action, along with monitoring, establish an energy management improvement program. The plan assures progress is to be made. Visibly publicizing accomplishments, and prompt positive feedback, challenge the employees to do better.

Design of facilities and processes should reflect the lessons learned from managing cost-effective energy utilization in existing facilities. One principle is "doing it right the first time." Incorporating cost-effective energy efficiency design into new facilities and processes capitalizes on an incremental investment to improve energy efficiency.

Successful projects consider cost-effective energy efficiency improvements throughout the project design phase, design development phase, and as-built phase. The project team has the resources active at all phases to have buy-in by all team members including energy management. Then, project schedule, cost, and functionality should not be drastically compromised.

During the as-built phase, processes and systems should be commissioned—comparing actual performance against expected design performance. Commissioning gives good baseline data, identifies good designs, and points to those processes and systems that need performance improvements.

Conclusions

These critical success factors are the first few clear steps to implementing the change from energy conservation to energy strategic planning. Other steps need to be identified to develop the total plan and activities necessary to implement the change to energy strategic planning. The completion of the transition stage will help a company to integrate energy management plans into its business plans.

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A Decade of Energy R&D--Implications for the Future

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1985 MARKS THE TENTH ANNIVERSARY OF THE START-UP OF THE ENERGY Research and Development Administration (ERDA) and the beginning of the nation's first coordinated non-nuclear energy R&D programs, in conservation, renewable energy and fossil energy. The programs have undergone rapid changes—from a combined budget of about $200 million in 1975 to more than $2 billion in 1980 and back down to $700 million by 1983.

In the Ford Administration they were aimed primarily at technology development and demonstration; in the early Carter years commercialization became the key word; and with the Reagan era basic research has become the primary focus. Despite these changes, it seems appropriate to examine the history of the past decade and see what lessons, if any, it holds for the future.

This article will focus on the conservation and solar energy research and development programs because these are the ones I know best. For three years I was a program manager and policy analyst in solar energy at DOE, and for five years I was the staff person in charge of recommending authorization budgets for the DOE conservation and solar energy R&D programs to the chairman of the House Science and Technology Committee.

This article is abstracted from a keynote address given at AEE's 8th World Energy Engineering Congress, October 1985. *The views presented are those of the author, and do not represent the position of OTA.*

We can identify three distinct phases to the conservation and solar research and development programs: rapid growth (1975-1980); rapid contraction (1981-1983); and relative stability (1984-1986). From 1975 to 1980 the conservation budget grew from $13 million to $300 million and the solar budget from $42 million to $580 million, or by factors of 23 and 14, respectively.

By 1983, however, those programs had been cut to $125 million or 42 percent of the 1981 budget for conservation and to $202 million or 35 percent of the 1981 budget for solar. Since then the programs have undergone a period of remarkable stability.

The conservation R&D programs have actually grown somewhat since 1983, to about $175 million in 1985, or 40 percent above their 1983 levels. The Interior Appropriations Bill passed by the House recently would increase that to $190 million in 1986, while the Senate bill, which has not yet reached the floor, would budget $168 million for those programs. The solar programs have been cut modestly from year to year, falling to $178 million in 1985 and to $157 million in the conference on the FY 1986 Energy and Water Appropriation Bill between the House and the Senate in October, 1985.

Lessons Learned—For a Crisis

Suppose we had another crisis in the late 1990s—domestic oil and gas production fall off, the Middle East gets closed off by a series of fundamentalist Islamic revolutions, and electric utility reserve margins get dangerously low. What could we learn from our response to the crisis of the 1970s?

1. Technology development and demonstration programs are not the best short-term responses to a perceived crisis. An initial response to the 1973 energy "crisis" was to search for new technologies and to put in place major technology development and demonstration programs. However, today few of the technologies developed by the ERDA/DOE programs are either in the marketplace or exhibiting significant market penetration. The reason is that technology development and commercialization is a 15-20 year process that cannot be speeded up by the will of Congress or the executive branch. The crash programs set up in the mid 1970s to accelerate the development and commercialization of new energy technologies were generally unsuccessful and costly.

2. Market-oriented policies produce significant results in the short-term. The powerful response of individuals and organizations to market signals has been well documented. Among the most successful policies of the 1970s were those that attempted to modify consumer and producer behavior through creative use of the energy marketplace. The decontrol of oil and natural gas prices by the Crude Oil Windfall Profits Tax Act of 1979 and the Natural Gas Policy Act of 1978, the deregulation of small electric power production and cogeneration by the Public Utilities Regulatory Policy Act of 1978 and the market incentives offered by the renewable energy tax credits of the Energy Security Act of 1980 are all examples of market-oriented policies which appear to have had some success in changing the behavior of energy users and producers. However, there are market barriers and institutional and individual rigidities that inhibit an effective response to market signals. Ironically, the government has spent less than a thousandth the resources on understanding individual and institutional responses to the changing energy situation that it has on new energy-producing technologies.

Lessons Learned, Stable Long-Term Programs

If we assume that the next ten years are likely to be similar to the last five, with stable energy prices and supplies and no major crises, then what can we learn from the past ten years that would improve the running of a stable energy R&D program in the future? To understand the lessons of the past ten years of energy research and development it is useful to think in terms of **scale** (small to large), **stage** (research through demonstration) and **role** (federal versus private sector) as organizing categories.

1. Scale. The natural impulse of the Federal government is to fund large projects. The problem is large, the Nation is large, the government is large and its favorite contractors are large. Moreover, it is easier to fund a single $10 million project than to write contracts for 100 $100,000 projects. And further, engineering economics always seems to lead to predicted economies of scale.

However, recent history shows the government's tendency to think large and the engineering economist's tendency to predict economies of scale to both be wrong. The two big technological showpieces of the early 1970s energy programs—the breeder reactors and synthetic fuels—are nowhere near commercialization, while biomass, passive solar, solar hot water, small wind, low head hydro, cogeneration, industrial energy efficiency and energy management technologies are all actively competing in the marketplace. The utilities are moving away from large nuclear and coal fired powerplants toward smaller projects that tie up less capital and allow capacity growth to follow load growth more smoothly.

In the renewable technologies we can see the problems of large scale quite dramatically. The centerpiece of the solar thermal program has been for years the central receiver technology. Yet, after a successful pilot plant demonstration at Barstow there are no immediate plans among any of the industrial firms involved in the central receiver program to commercialize the technology.

Meanwhile, two small companies, Luz of Israel and LaJet of Texas have built privately-funded commercial solar thermal power plants using distributed-receiver technology and are selling electricity to the grid from them today. The reason: the central receiver requires a 100 megawatt size to achieve the same economies as can be obtained from a 15 megawatt distributed receiver system. While it is possible to raise the $60 million required to build the smaller plant on the capital markets, the $400 million needed for a large power tower is beyond the capability of anyone to finance.

In wind, the government has successfully demonstrated a 2.5 MW wind turbine, the MOD 2, and is building a 3 MW version, the MOD 5, in Hawaii. Meanwhile, small and medium sized wind machines, built by the hundreds in the windy Altamant, Tehachapi and San Gregorio passes using tax credits and third party financing, are beginning to show cost and performance characteristics that could be competitive in an unsubsidized market.

Vertical axis wind turbines in the 150 kw range, which were developed by the Federal government at a tenth the cost of the multi-megawatt machines, have already achieved the cost goals for the commercial version of those machines. A consensus appears to be developing in the utility industry that the advantages of mass production and simple site assembly compensate for economies of scale in the larger machines and make the intermediate size (150-750 kw) the technology of preference for the near term.

2. Stage. The demonstration program is clearly the most difficult and controversial of the stages of Federally sponsored research and development. The Clinch River Breeder Reactor and the SRC I and

and II Synthetic Fuels Demonstration plants of the late 1970s illustrate the problems inherent in demonstrations.

All three developed enormous cost escalations from $650 million in the initial phases to over $3 billion apiece by the end. All three developed powerful political constituencies that made termination difficult. All three were terminated after considerable expenses with little to show for the experience. But the problems of demonstrations are not confined to large scale technologies.

The solar heating and cooling demonstration program of the late 1970s experienced many of the problems of the breeder reactor, synthetic fuels and large wind turbine demonstrations discussed above. The Solar Heating and Cooling Act of 1974 that created the demonstration program envisaged a five-year, $60 million effort that would demonstrate the practical use of solar heating technology within three years and of solar heating and cooling technology within five.

Instead, the program lasted more than seven years, cost upwards of $550 million dollars and wound up demonstrating that active heating/cooling systems were uneconomic and inefficient, and that active heating systems were marginally economic but unreliable. Systems costs averaged $38-$77 per square foot, instead of the $4 to $8 per square foot predicted by some observers in advance.

Nearly half the systems experienced operating problems, and performance was considerably below expectations—an average of 11 percent of the incident solar energy was delivered to the load in the instrumented active solar homes monitored by DOE. Passive solar homes, by contrast, with much lower costs, delivered 36 percent of the incident energy to the home. Thus for more than $500 million we learned that passive solar outperforms active solar—an awfully expensive way to learn a simple lesson.

The lessons that can be learned from the unsuccessful demonstrations of the DOE energy program of the 1970s are the following:

1. When the government pays most of the costs of a demonstration program there is little incentive for the private sector participants to contain costs and meet performance goals.

2. When a technology is picked by a Federal agency or Congressional committee it is often not the least expensive or most efficient option for the job.

3. When a primary objective of a demonstration is to show government commitment to a technology, rather than to achieve specified cost and performance targets, the potential for failure is high.

The good news is that these lessons appear to have been learned by at least one major actor in the government, the House Interior Appropriations Subcommittee. In its report accompanying the FY 1986 Interior Appropriations Bill the Subcommittee recommended the transfer of $750 million from the Synthetic Fuels Corporation to the DOE for a "clean coal technology demonstration program." However, it made the following stipulations with respect to that program:

> The Committee believes that projects in this program should be industry projects assisted by the government, and not government directed demonstrations. To emphasize this view the Committee has included a requirement that government funding not exceed 50% of project cost. The Committee has also included provisions related to cost-sharing to provide that: project sponsors must cost-share each phase of the project; cost overruns are to be shared in the same ratio as project costs; royalties and revenue sharing from other plants are not considered cost-sharing; and in-kind contributions [are] only considered cost-sharing to the extent they would be expensed, amortized or depreciated in normal business practice.

These lessons, of course, have long been understood by the most successful conservation or solar energy R&D program, the DOE industrial energy conservation program. The DOE industrial energy conservation program co-sponsors technology development and demonstration projects with industry, with Federal costs running from 50 to 90 percent of the total project costs. The 23 projects that have been completed by the program to date, at a total Federal cost of $34.3 million, are currently saving the nation more than $85 million per year in energy costs. The most significant factor in the success of the projects, according to Maxine Savitz, the former DOE Deputy Assistant Secretary for Conservation, was "the contractor's incentive for conducting the project."

3. **Roles.** The discussion of private sector cost-sharing on demonstration programs leads to the final category for lessons learned from the Federal energy research and development programs, that of the proper role of the government and industry.

In the early days of the energy program it was assumed tacitly that the Federal government was primarily responsible for everything from research through commercialization. In the early 1980s it became administration policy that the Federal government was responsible for nothing beyond basic research.

In reality, neither of those two extreme positions appears particularly desirable. The former leads to large government expenditures on demonstration projects that never make it into the marketplace. The latter leads to half-completed development efforts on technologies that never have the chance to get to the marketplace.

What is needed is a partnership between industry and government that extends all the way back to the research phase and all the way forward to the technology transfer and commercialization phases.

Although some feel that the Federal government can be exclusively in charge of the research phase of the R&D process, I believe that industry involvement at this stage is equally important to ensure that the research is relevant to the needs of the ultimate manufacturer, distributer and user. That involvement should take two forms: first, some minimal cost-sharing on any Federal research contract to an industrial laboratory. This cost-sharing ensures that there is some interest in the research on the part of industry and some possibility that it may be ultimately commercialized.

Second, structured industry involvement in program planning and evaluation from the start. This involvement should preferably be in the form of a regularly-meeting working group which reviews budget and program documents and makes recommendations early enough to be acted upon.

In 1983 and 1984, when I was on the Science Committee, we held a series of building energy research workshops with extensive involvement from private sector organizations. Their strongest recommendation was that some kind of permanent, regularly-meeting entity be set up to coordinate private sector research recommendations to the DOE programs.

On the other end of the R&D spectrum, successful programs like the industrial energy conservation program have shown the importance of active government involvement in technology transfer and even commercialization assistance where market barriers inhibit the diffusion of a new technology. This includes measures like the renewable energy tax credits, which will almost undoubtedly not be renewed.

The most important news we have learned from a decade of energy R&D, however, is the importance of working as hard on the demand side of the energy picture as we do on the supply side. The early government response to the perceived energy "crisis" of the mid 1970s was to become captivated with a set of seemingly-attractive supply options—breeder reactors, synthetic fuels plants, advanced renewable technologies. Only with the publication of a series of influential reports stressing conservation in 1979 and 1980 did Federal policymakers become convinced that energy efficiency was the most important energy option for the near-term.

The Reagan Administration, unfortunately, had to repeat the same learning process between 1981 and 1983, but has now apparently come out on the other end. The conservation R&D programs have not only received stable budget requests for each of the last three years, but have been allowed to prepare multi-year program plans containing detailed budget numbers that are a model of thoughtful and thorough program planning.

One of the best lessons that could be learned from the past decade of energy R&D would be to make the conservation multi-year plan mandatory reading for all managers of applied research and development programs.

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